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PATENT & TRADEMARK OFFICE

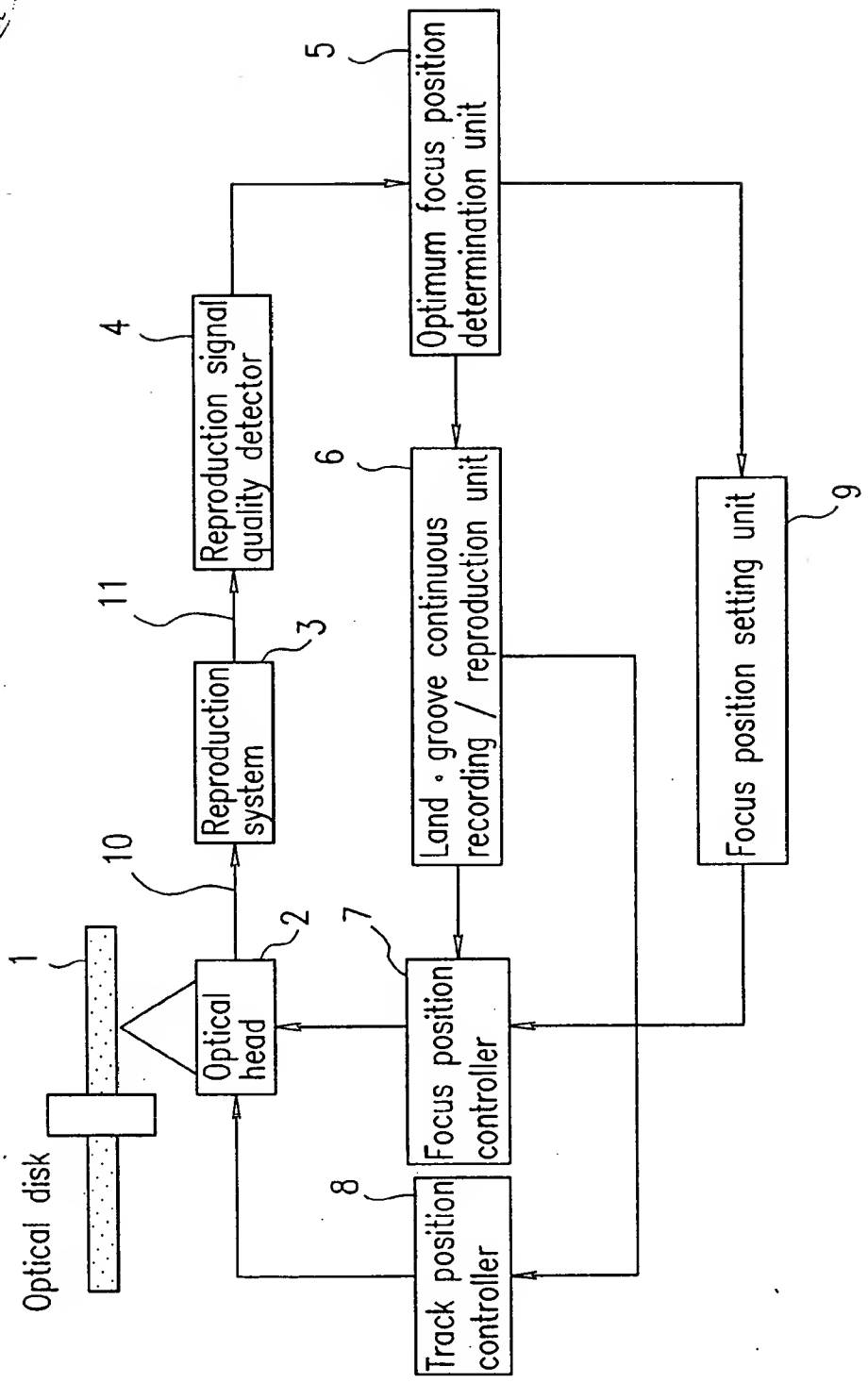


FIG. 1

FIG. 2

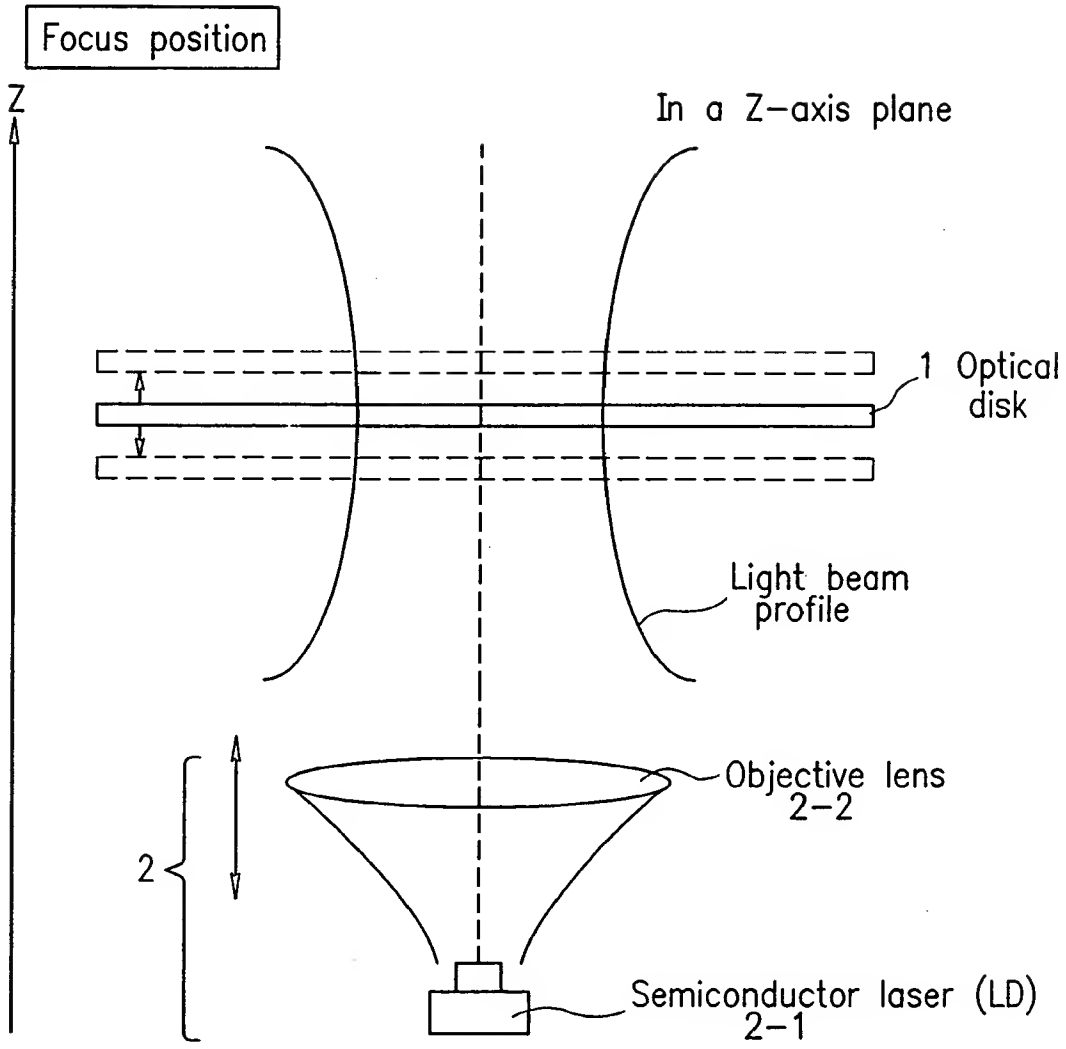

Focus position
Z
In a Z-axis plane
1 Optical disk
Light beam profile
Objective lens 2-2
2
Semiconductor laser (LD) 2-1

FIG. 3

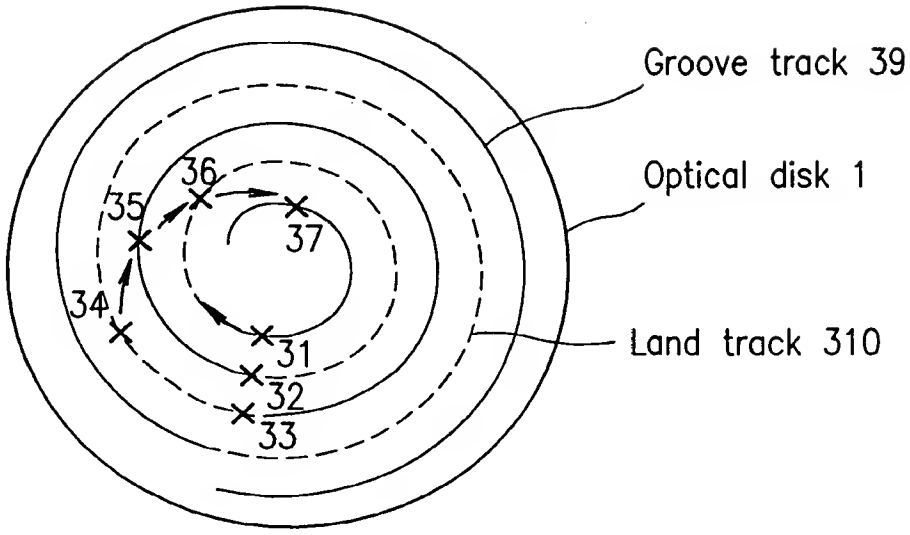

Groove track 39
Optical disk 1
Land track 310
36
35
37
34
31
32
33

FIG. 4A

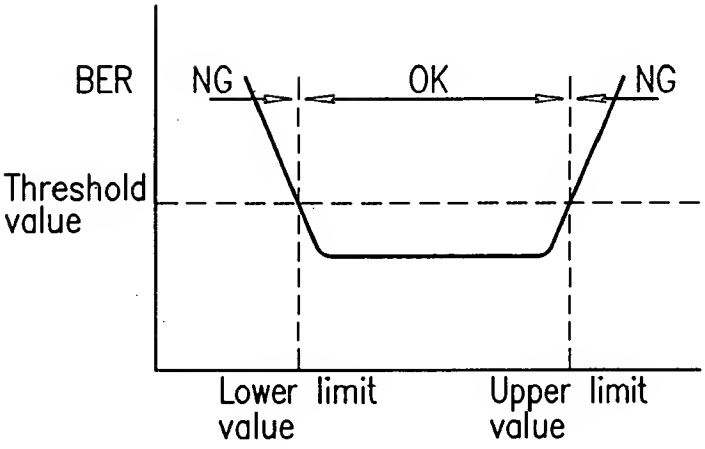

BER
NG
OK
NG
Threshold value
Lower limit value
Upper limit value
Recording focus position

FIG. 4B

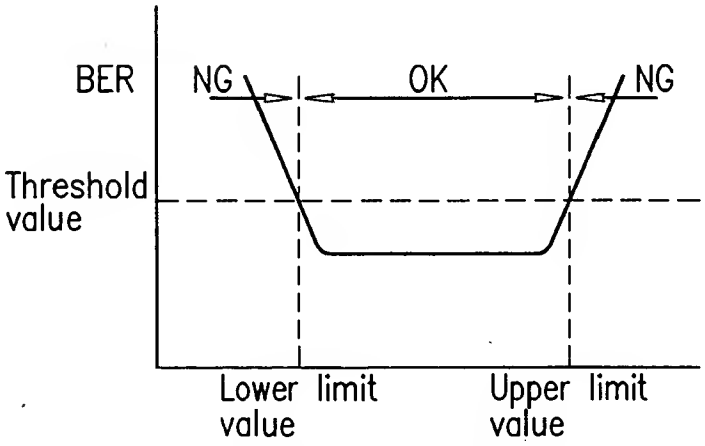

BER
NG
OK
NG
Threshold value
Lower limit value
Upper limit value
Reproduction focus position

FIG. 5

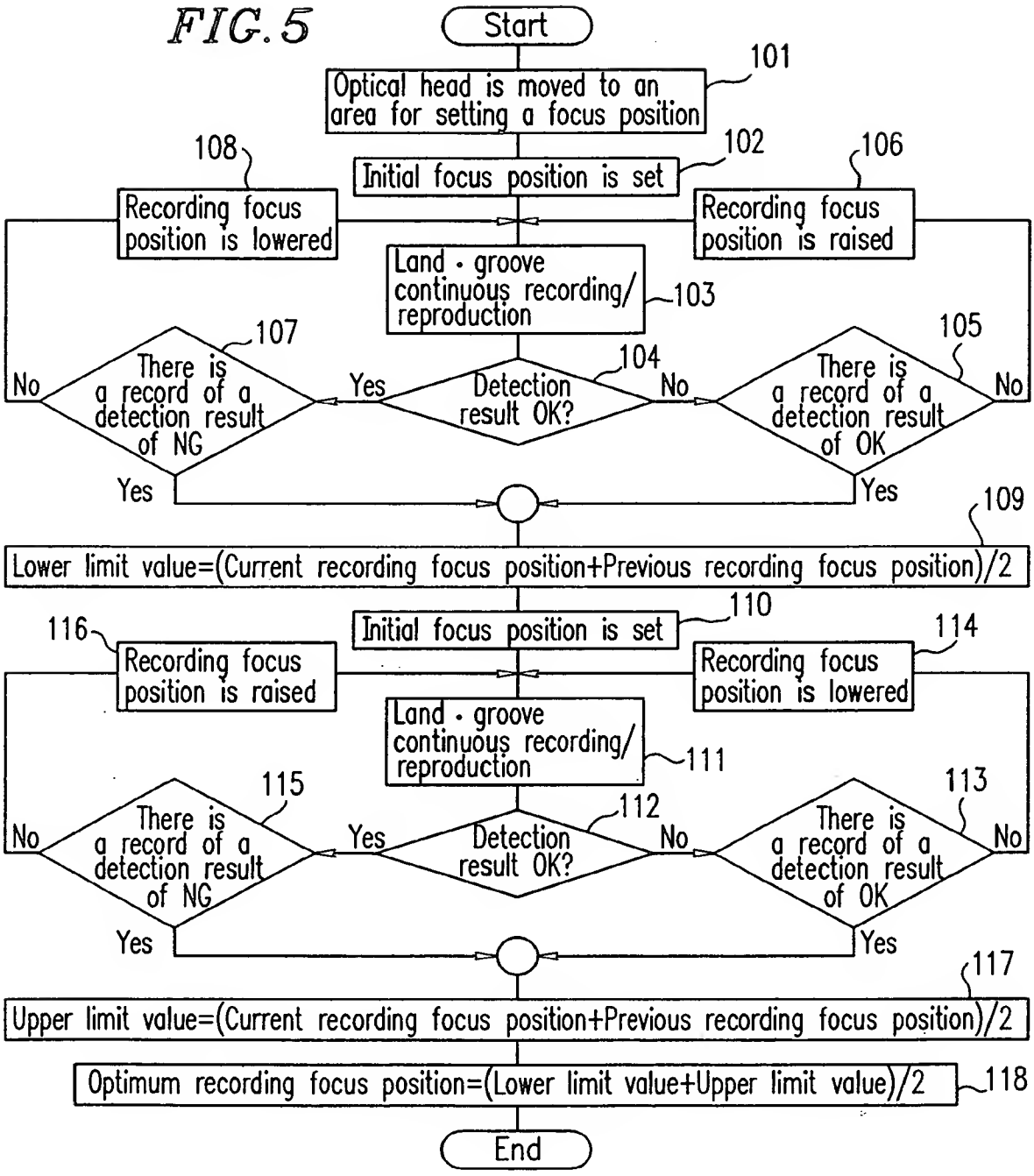

Start
Optical head is moved to an area for setting a focus position
101
Initial focus position is set
102
Recording focus position is lowered
108
Recording focus position is raised
106
Land · groove continuous recording/ reproduction
103
There is a record of a detection result of NG
107
Detection result OK?
104
There is a record of a detection result of OK
105
No
Yes
No
No
Yes
Yes
Lower limit value=(Current recording focus position+Previous recording focus position)/2
109
Initial focus position is set
110
Recording focus position is raised
116
Recording focus position is lowered
114
Land · groove continuous recording/ reproduction
111
There is a record of a detection result of NG
115
Detection result OK?
112
There is a record of a detection result of OK
113
No
Yes
No
No
Yes
Yes
Upper limit value=(Current recording focus position+Previous recording focus position)/2
117
Optimum recording focus position=(Lower limit value+Upper limit value)/2
118
End

FIG. 6

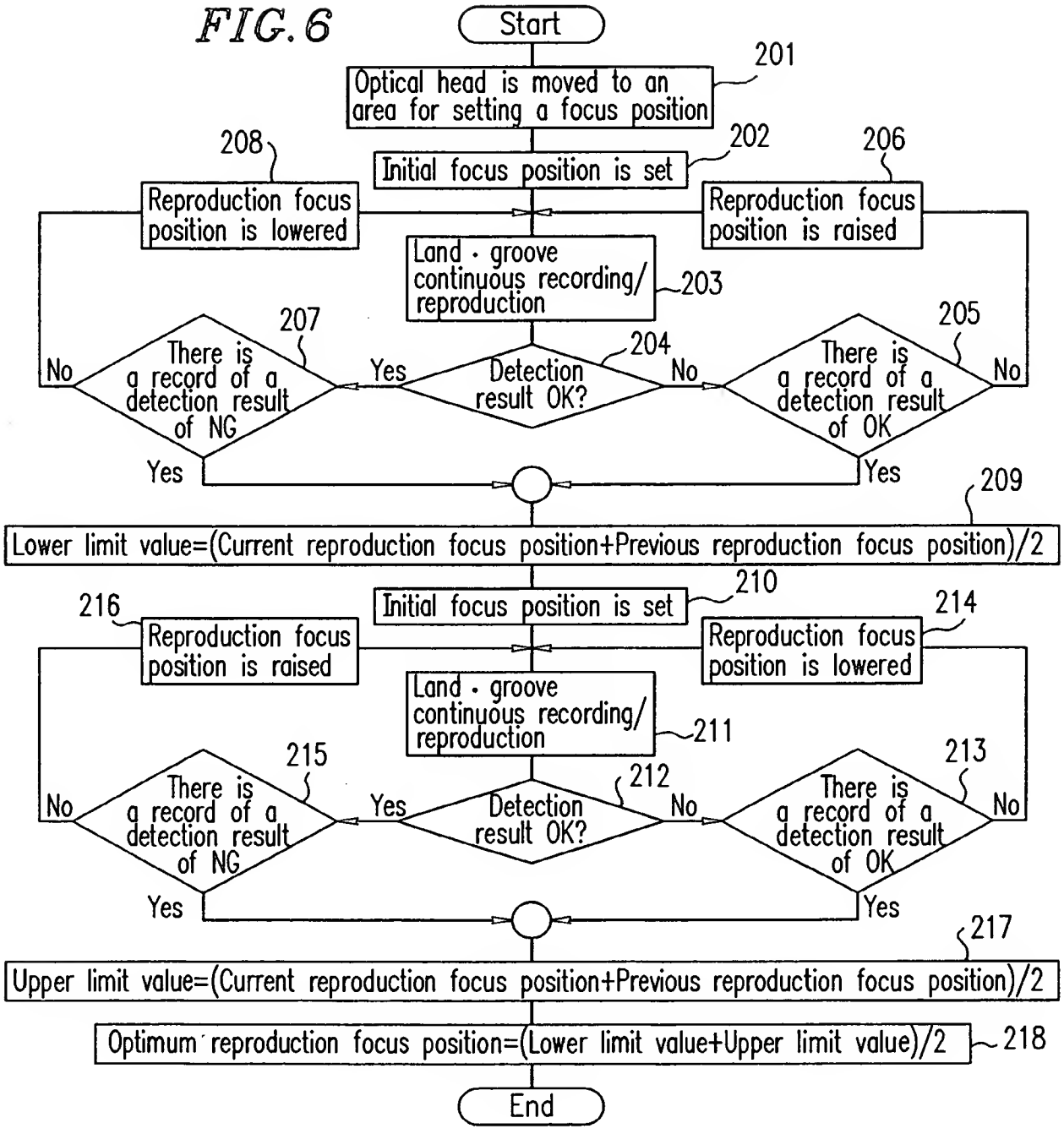

Start
Optical head is moved to an area for setting a focus position
201
Initial focus position is set
202
208
Reproduction focus position is lowered
206
Reproduction focus position is raised
Land · groove continuous recording/ reproduction
203
207
There is a record of a detection result of NG
No
Yes
204
Detection result OK?
No
205
There is a record of a detection result of OK
No
Yes
Yes
209
Lower limit value=(Current reproduction focus position+Previous reproduction focus position)/2
210
Initial focus position is set
216
Reproduction focus position is raised
214
Reproduction focus position is lowered
Land · groove continuous recording/ reproduction
211
215
There is a record of a detection result of NG
No
Yes
212
Detection result OK?
No
213
There is a record of a detection result of OK
No
Yes
Yes
217
Upper limit value=(Current reproduction focus position+Previous reproduction focus position)/2
Optimum reproduction focus position=(Lower limit value+Upper limit value)/2
218
End

FIG. 7

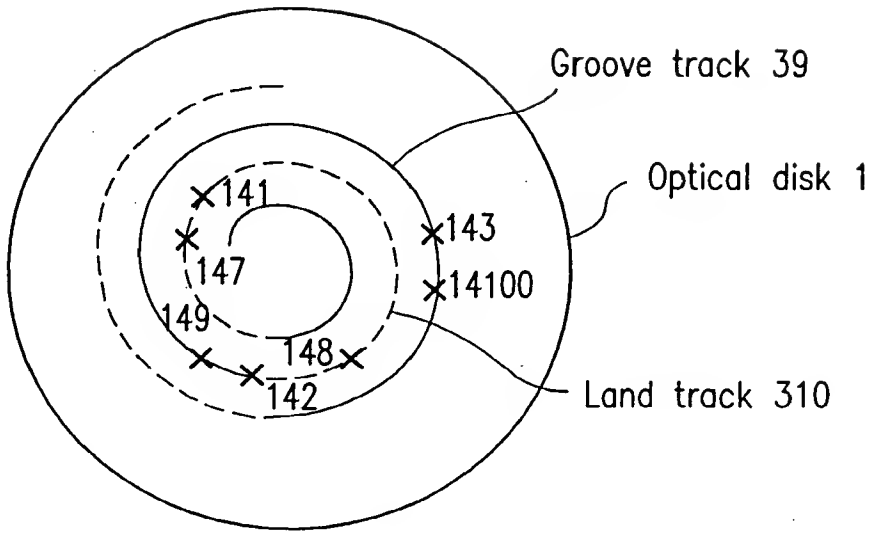

Groove track 39
Optical disk 1
141
143
147
14100
149
148
142
Land track 310

FIG. 8

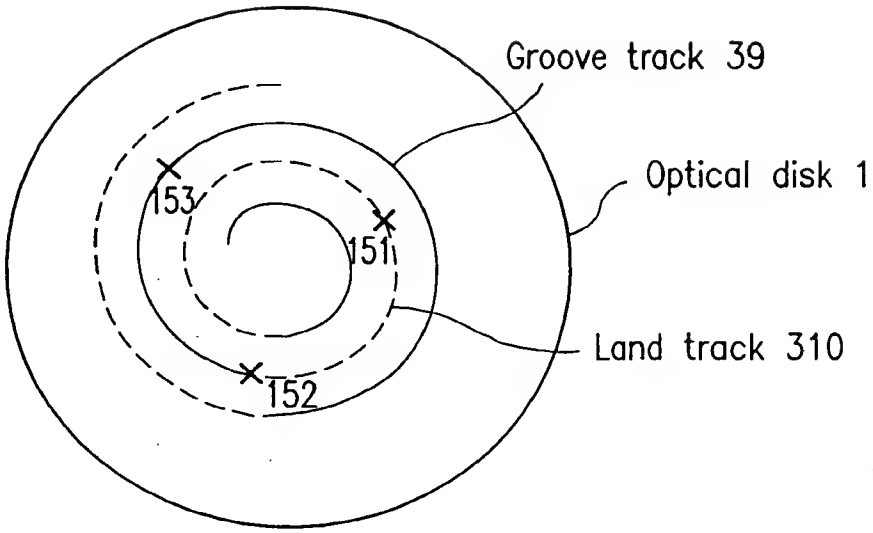


FIG. 9

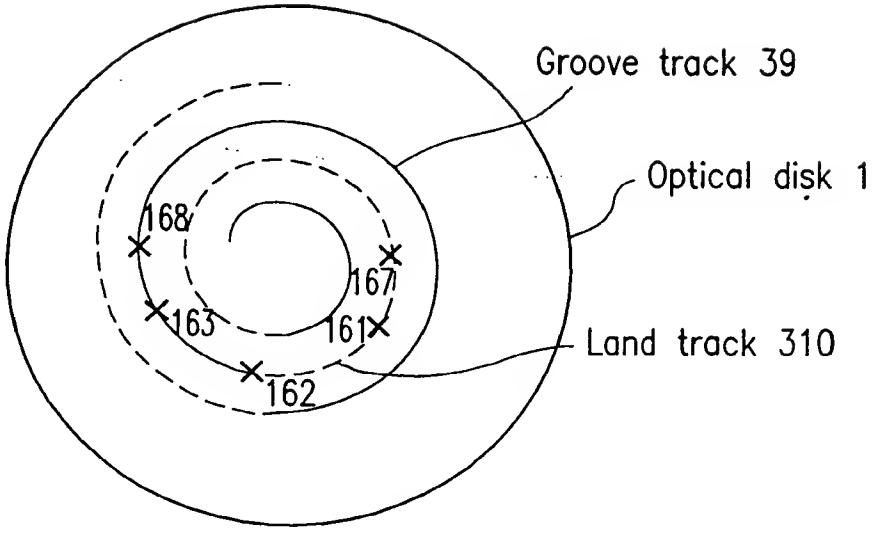

Groove track 39
Optical disk 1
Land track 310
168
167
163
161
162

FIG. 10

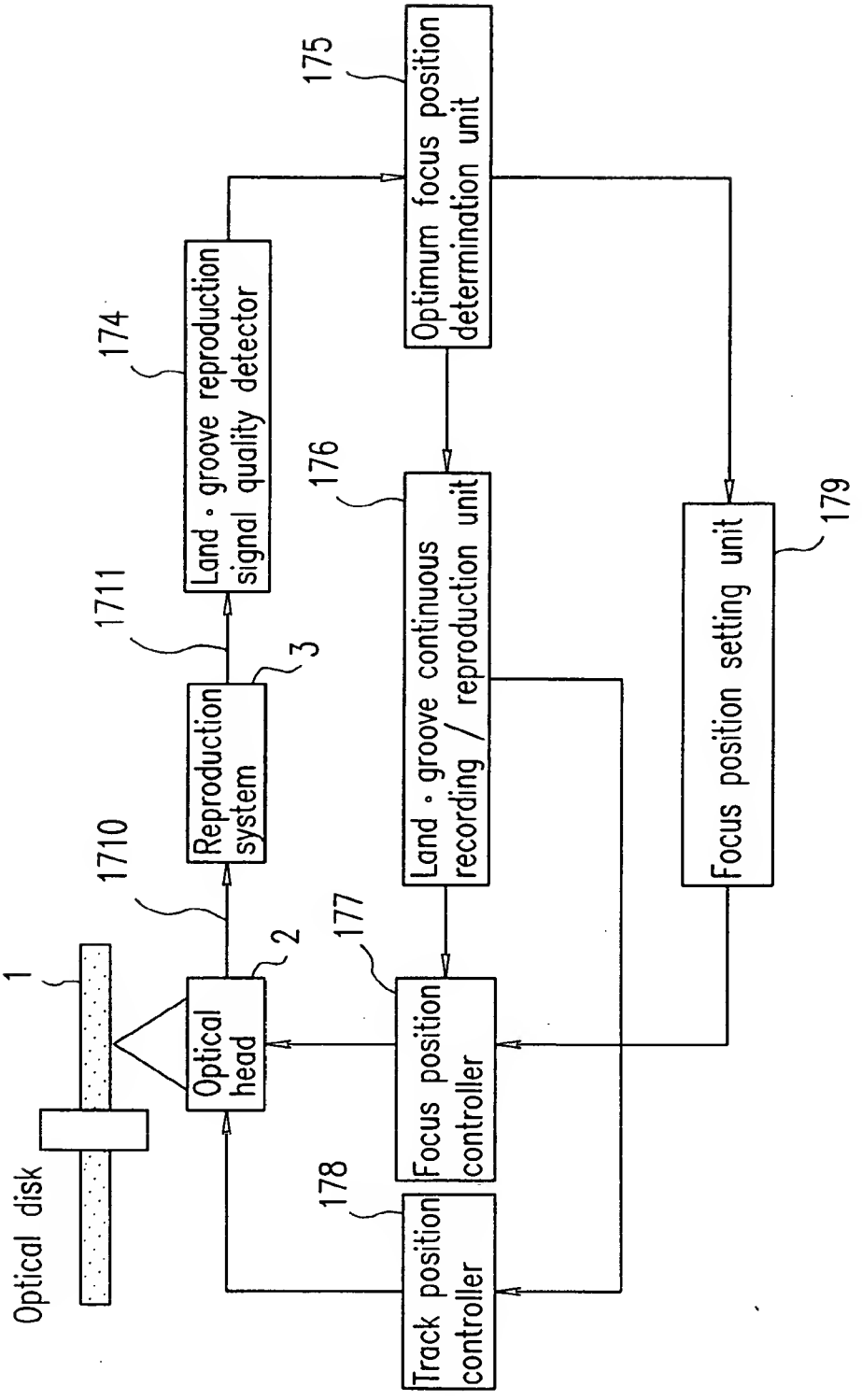

Optical disk
1
Optical head
2
Reproduction system
3
1710
1711
Land・groove reproduction signal quality detector
174
Optimum focus position determination unit
175
Land・groove continuous recording / reproduction unit
176
Focus position controller
177
Track position controller
178
Focus position setting unit
179

FIG. 11

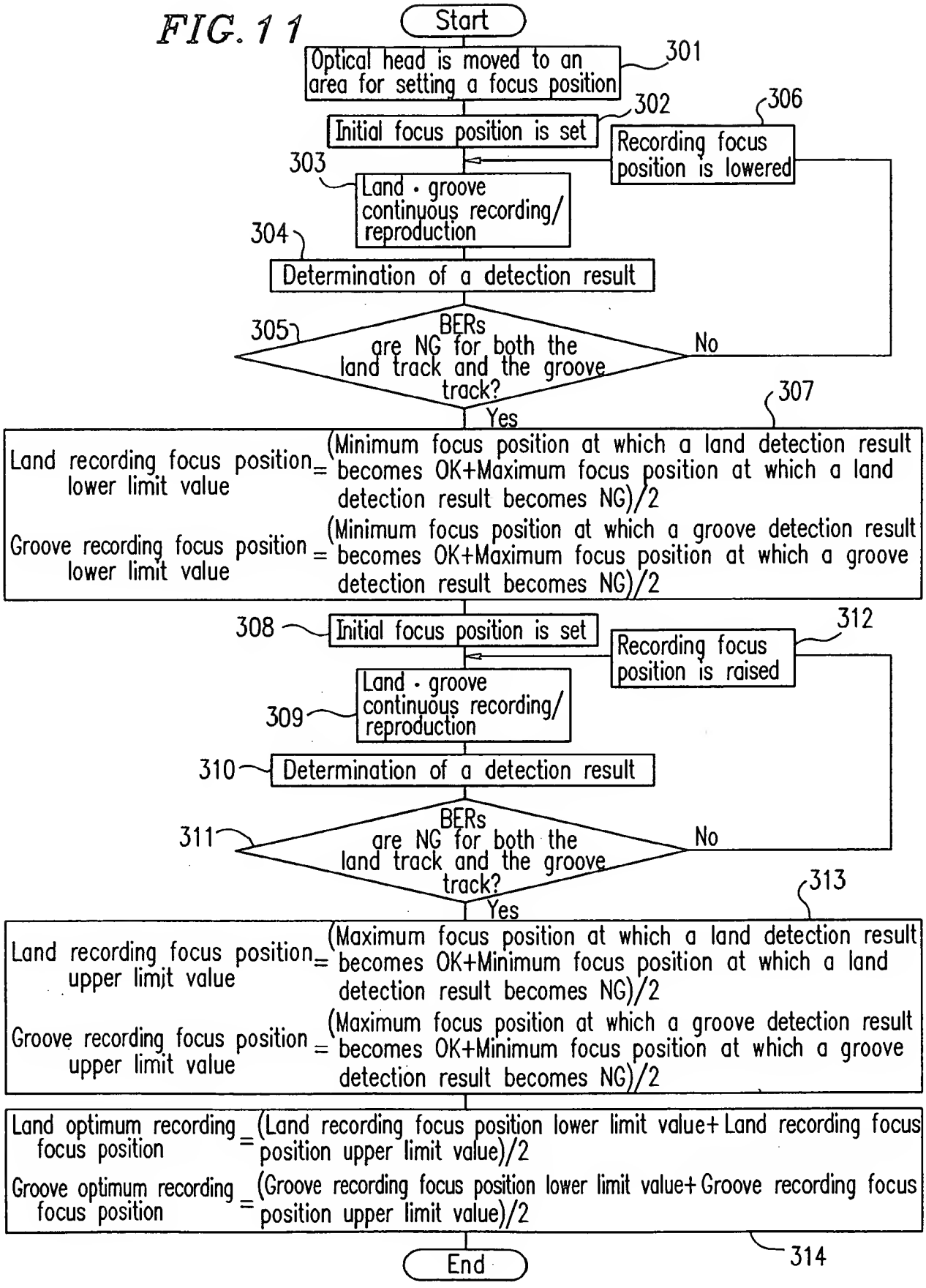
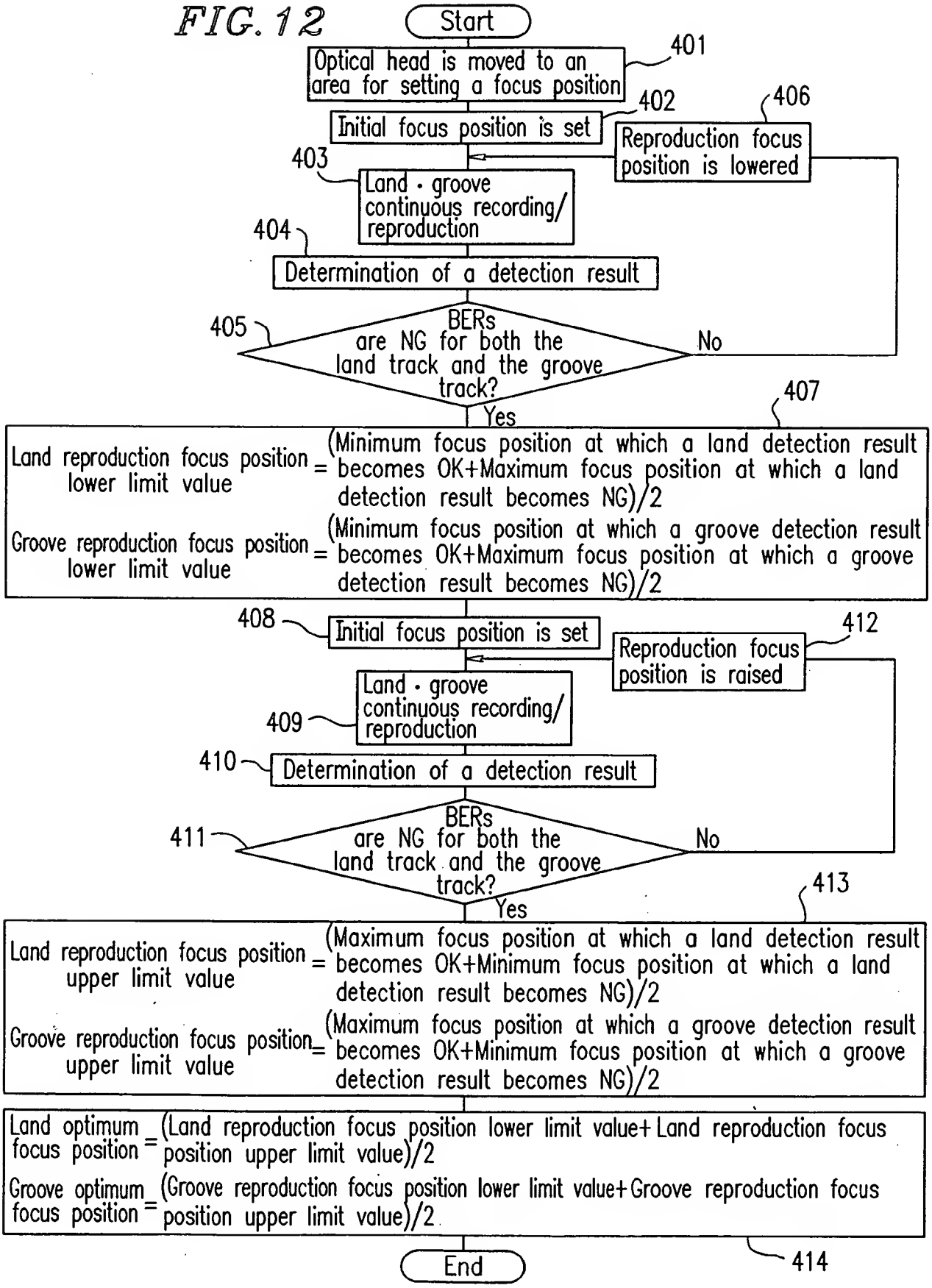

Start
Optical head is moved to an area for setting a focus position
301
Initial focus position is set
302
Recording focus position is lowered
306
303
Land · groove continuous recording/ reproduction
304
Determination of a detection result
305
BERs are NG for both the land track and the groove track?
No
Yes
307
Land recording focus position lower limit value = (Minimum focus position at which a land detection result becomes OK+Maximum focus position at which a land detection result becomes NG)/2
Groove recording focus position lower limit value = (Minimum focus position at which a groove detection result becomes OK+Maximum focus position at which a groove detection result becomes NG)/2
308
Initial focus position is set
312
Recording focus position is raised
309
Land · groove continuous recording/ reproduction
310
Determination of a detection result
311
BERs are NG for both the land track and the groove track?
No
Yes
313
Land recording focus position upper limit value = (Maximum focus position at which a land detection result becomes OK+Minimum focus position at which a land detection result becomes NG)/2
Groove recording focus position upper limit value = (Maximum focus position at which a groove detection result becomes OK+Minimum focus position at which a groove detection result becomes NG)/2
Land optimum recording focus position = (Land recording focus position lower limit value+Land recording focus position upper limit value)/2
Groove optimum recording focus position = (Groove recording focus position lower limit value+Groove recording focus position upper limit value)/2
314
End

FIG. 12


Start
401
Optical head is moved to an area for setting a focus position
402
Initial focus position is set
406
Reproduction focus position is lowered
403
Land · groove continuous recording/ reproduction
404
Determination of a detection result
405
BERs are NG for both the land track and the groove track?
No
Yes
407
Land reproduction focus position lower limit value = (Minimum focus position at which a land detection result becomes OK+Maximum focus position at which a land detection result becomes NG)/2
Groove reproduction focus position lower limit value = (Minimum focus position at which a groove detection result becomes OK+Maximum focus position at which a groove detection result becomes NG)/2
408
Initial focus position is set
412
Reproduction focus position is raised
409
Land · groove continuous recording/ reproduction
410
Determination of a detection result
411
BERs are NG for both the land track and the groove track?
No
Yes
413
Land reproduction focus position upper limit value = (Maximum focus position at which a land detection result becomes OK+Minimum focus position at which a land detection result becomes NG)/2
Groove reproduction focus position upper limit value = (Maximum focus position at which a groove detection result becomes OK+Minimum focus position at which a groove detection result becomes NG)/2
Land optimum focus position = (Land reproduction focus position lower limit value+Land reproduction focus position upper limit value)/2
Groove optimum focus position = (Groove reproduction focus position lower limit value+Groove reproduction focus position upper limit value)/2
End
414

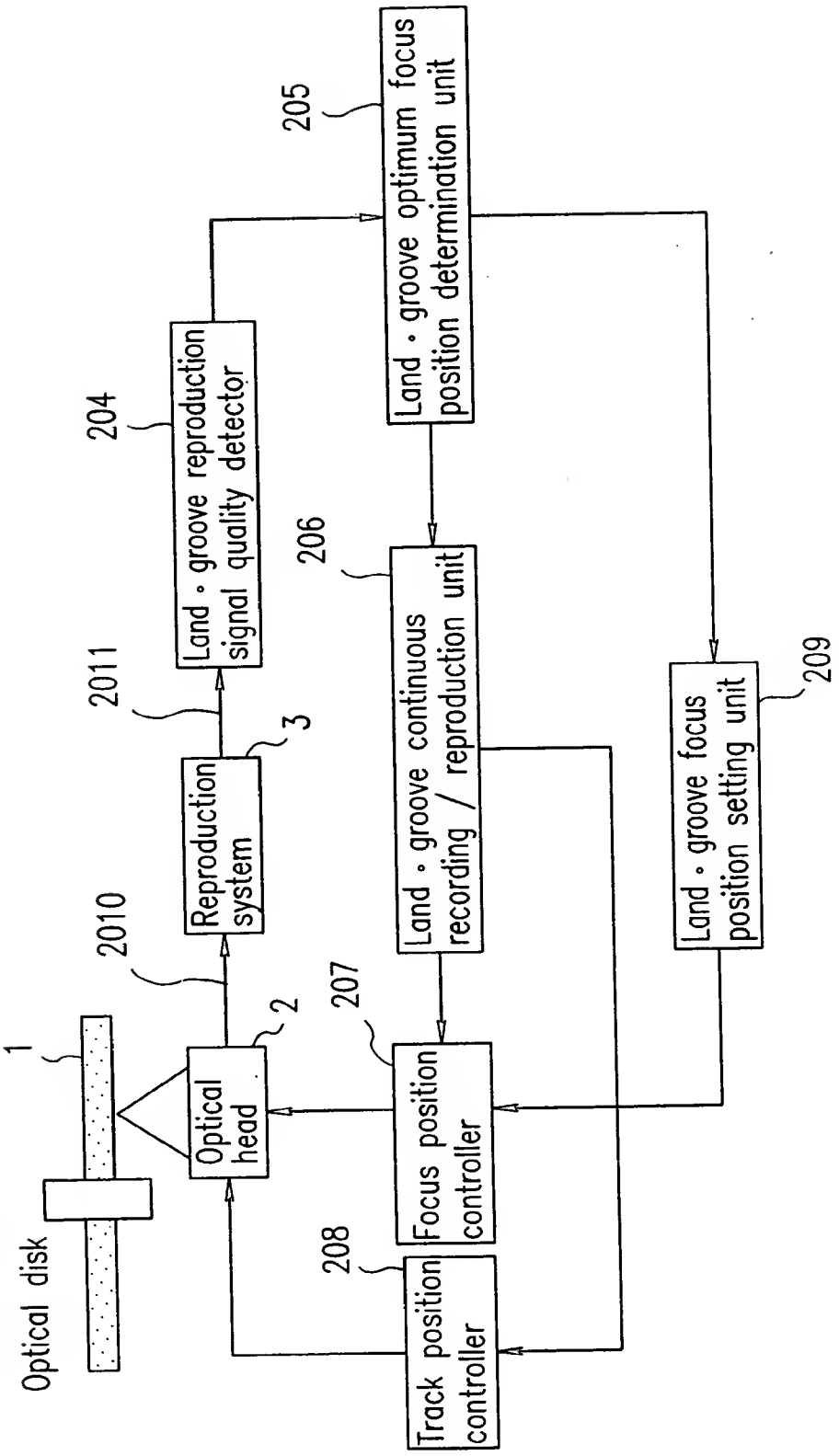

Optical disk
1
Optical head
2
2010
Reproduction system
3
2011
Land • groove reproduction signal quality detector
204
Land • groove optimum focus position determination unit
205
Land • groove continuous recording / reproduction unit
206
Focus position controller
207
Track position controller
208
Land • groove focus position setting unit
209

FIG. 13

FIG. 14A

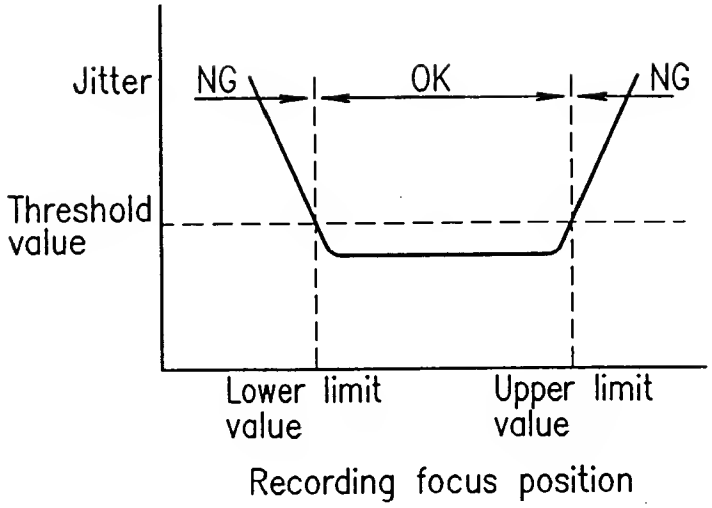


FIG. 14B

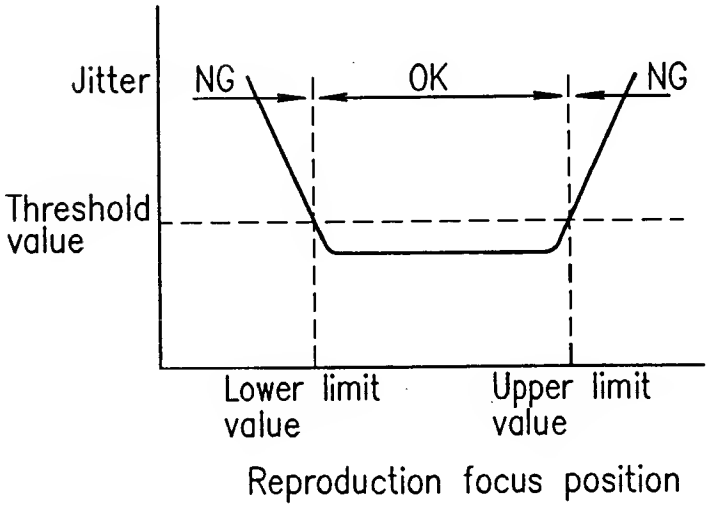


FIG. 15A

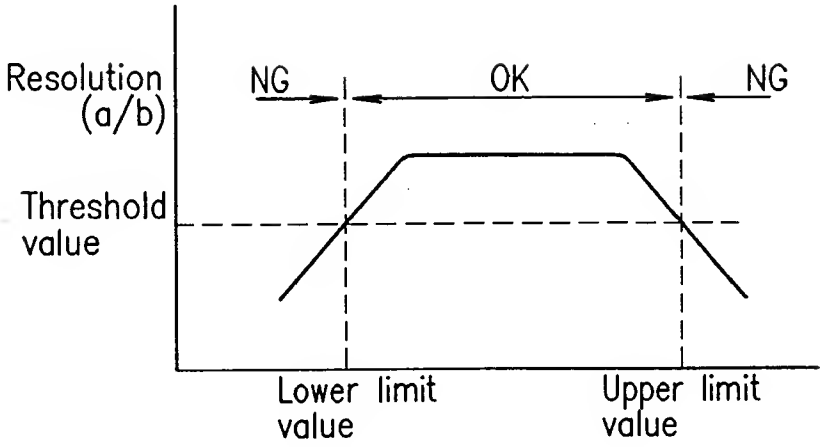


FIG. 15B

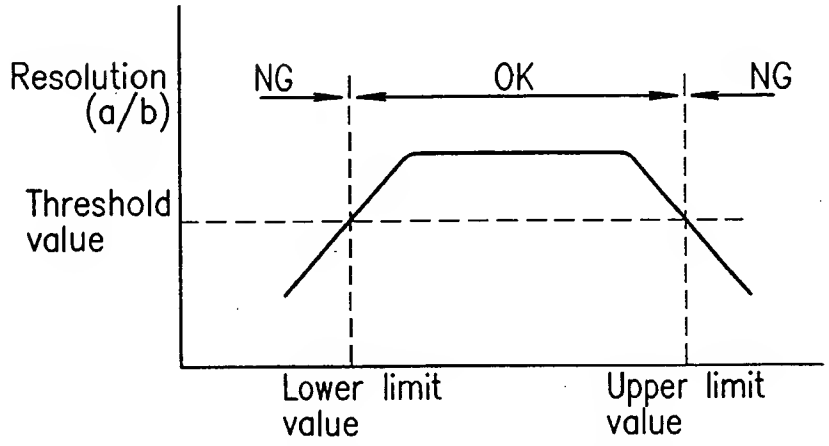


FIG. 16

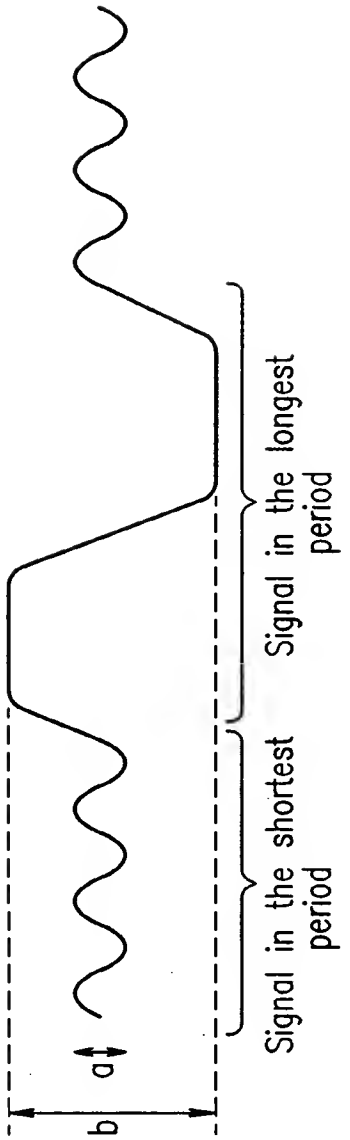

a
b
Signal in the shortest period
Signal in the longest period

FIG. 17A

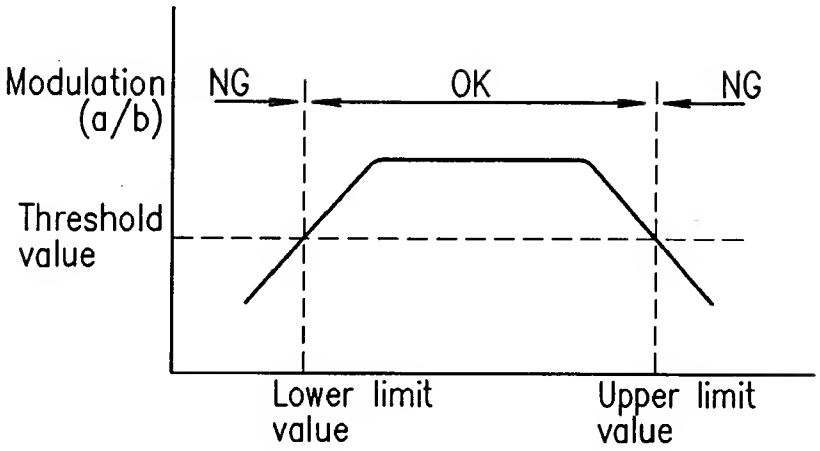


FIG. 17B

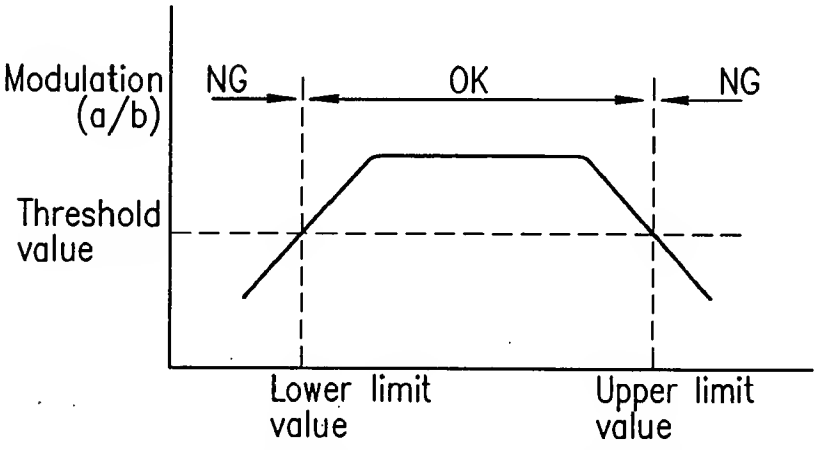


FIG. 18

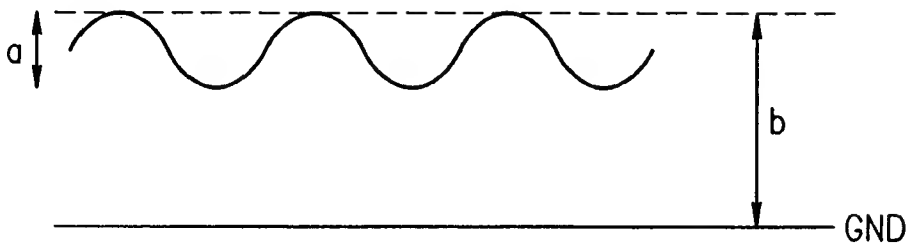


FIG. 19A

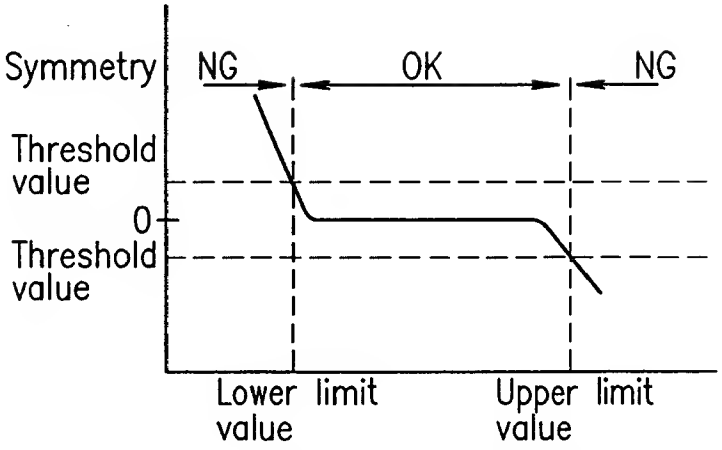


FIG. 19B

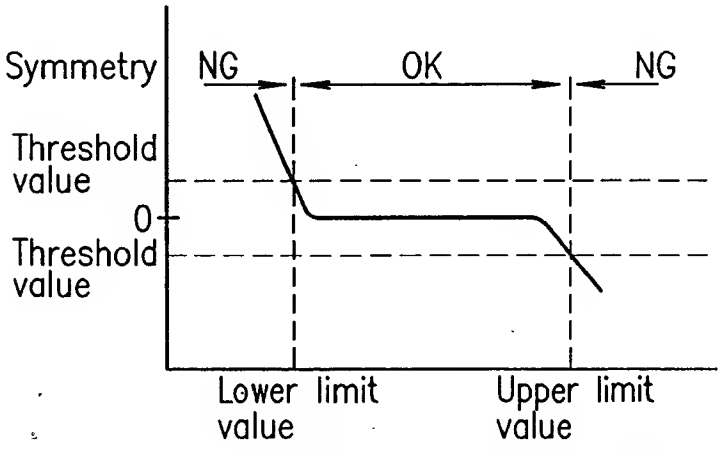


FIG.20

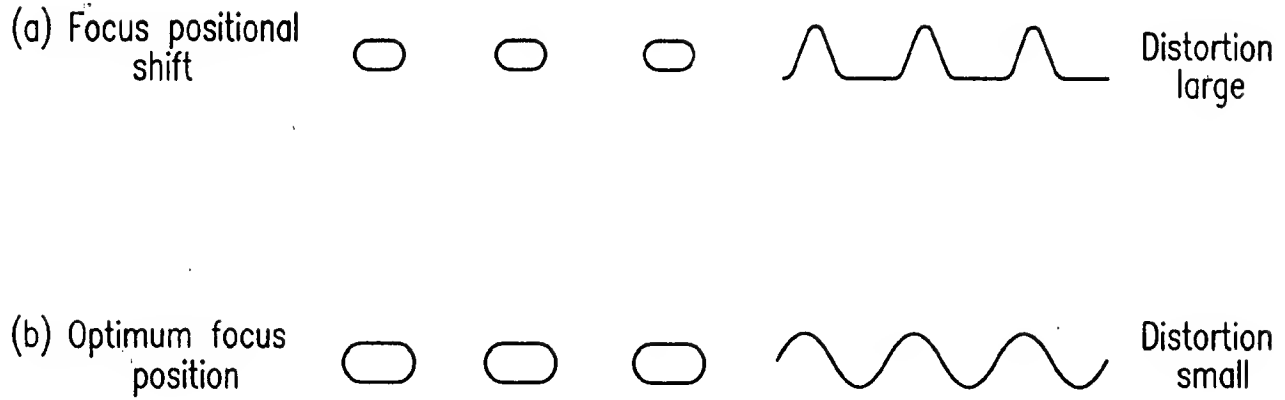

(a) Focus positional shift
Distortion large
(b) Optimum focus position
Distortion small

FIG. 21A

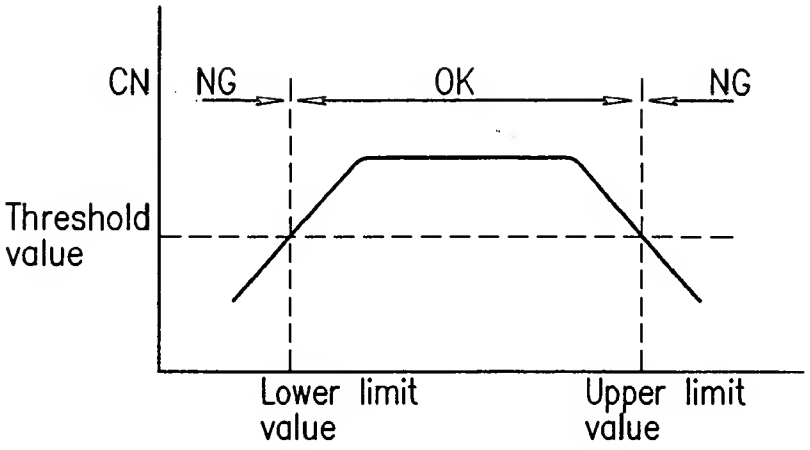


FIG. 21B

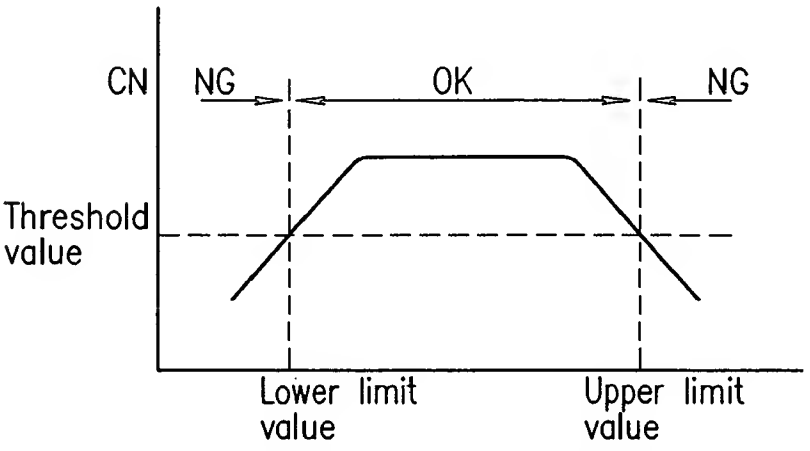


FIG. 22A

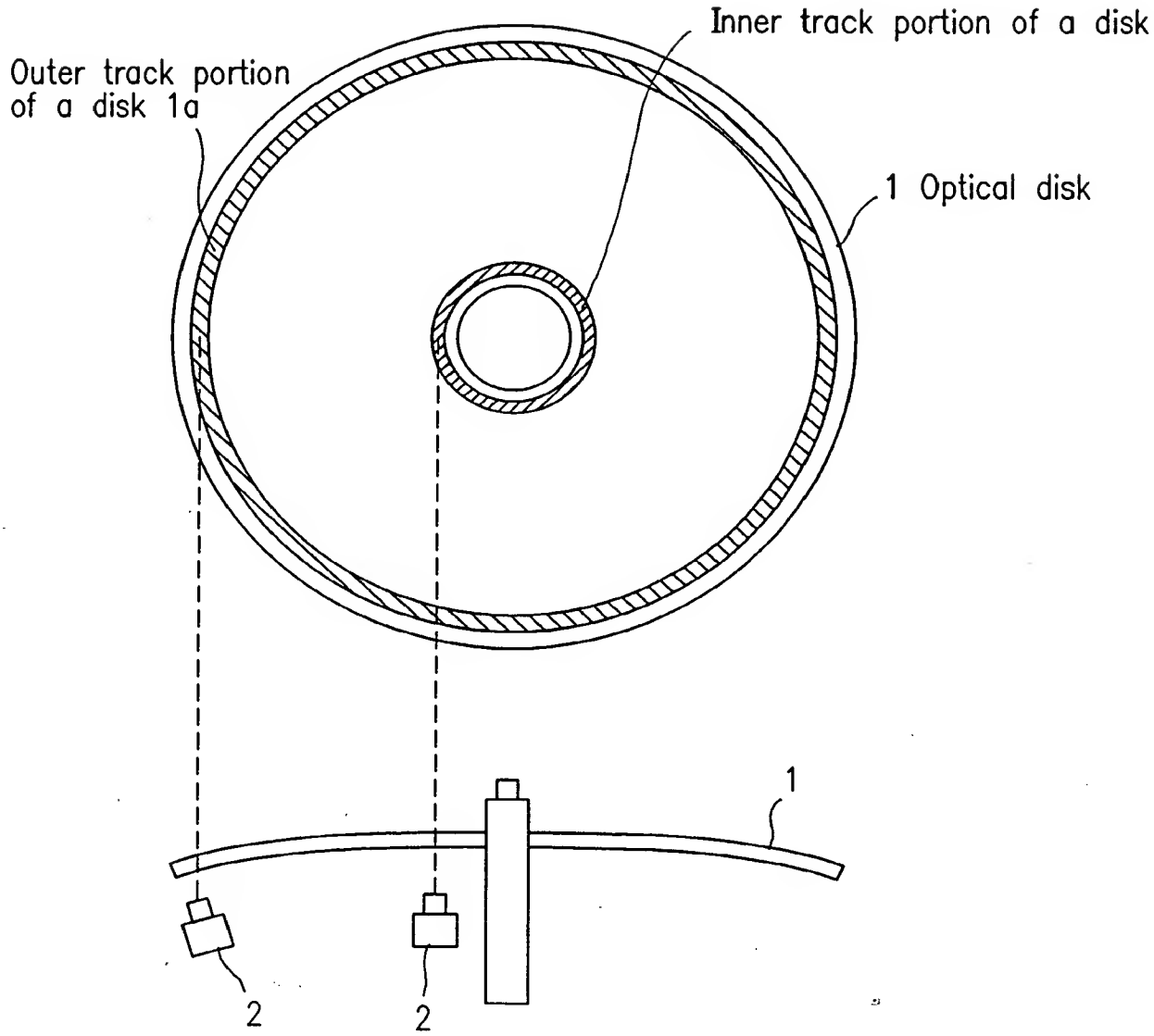

Inner track portion of a disk
Outer track portion of a disk 1a
1 Optical disk
1
2
2

FIG. 22B

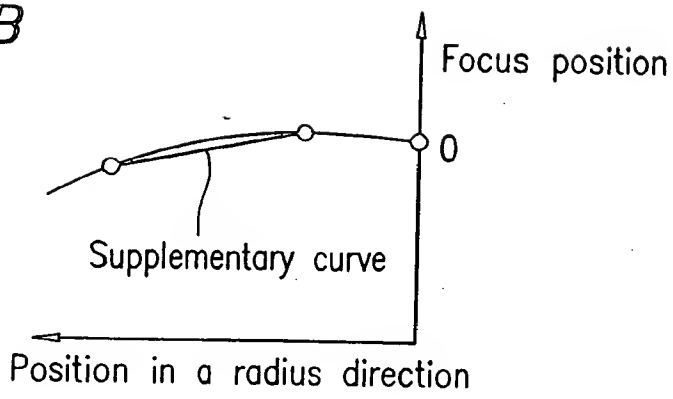


FIG. 22C

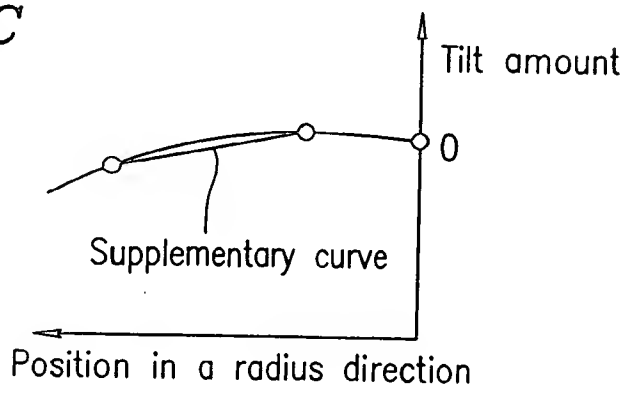


FIG. 22D

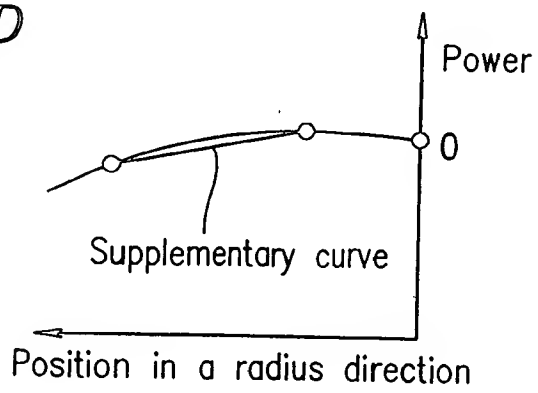


FIG. 22E

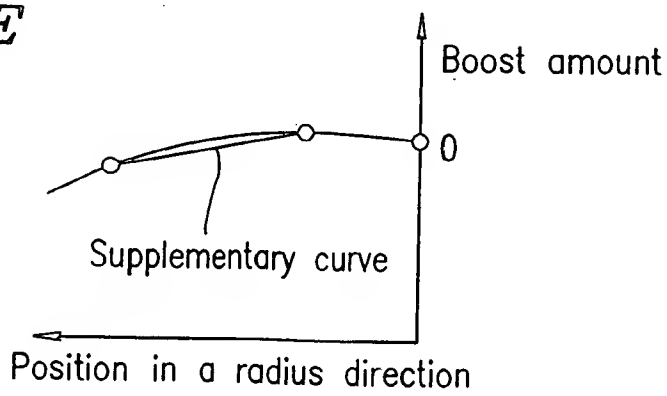


FIG. 23

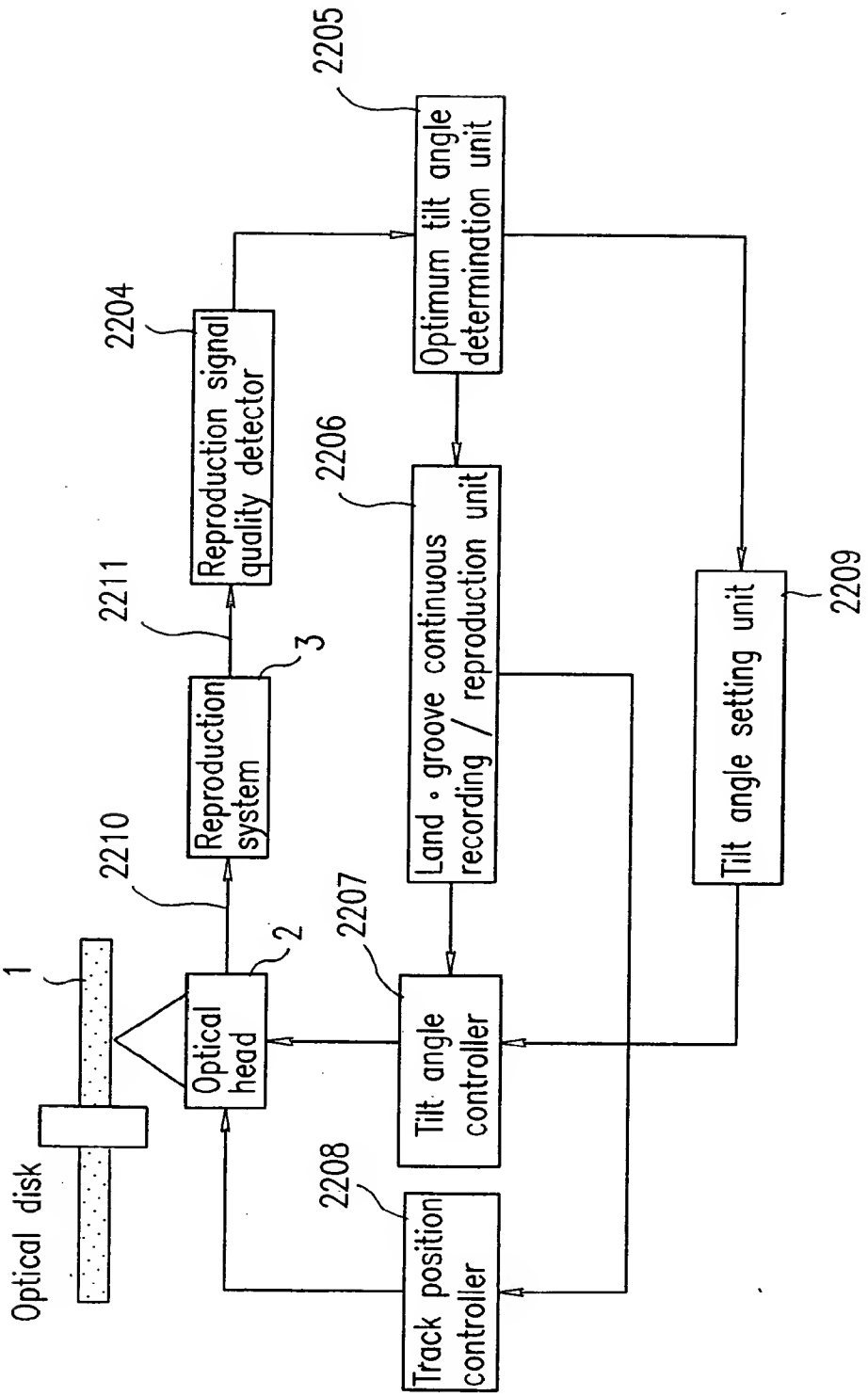

Optical disk
1
Optical head
2
Reproduction system
3
Reproduction signal quality detector
2204
Optimum tilt angle determination unit
2205
Land • groove continuous recording / reproduction unit
2206
Tilt angle controller
2207
Track position controller
2208
Tilt angle setting unit
2209
2210
2211

FIG. 24A

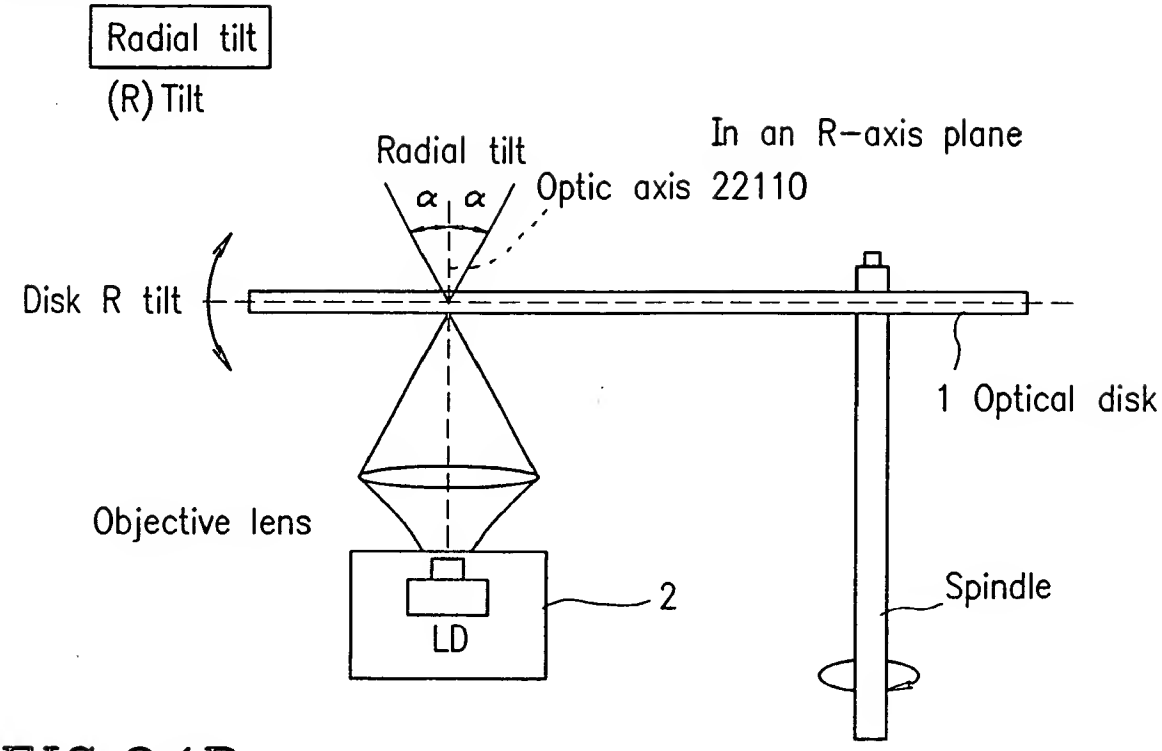


FIG. 24B

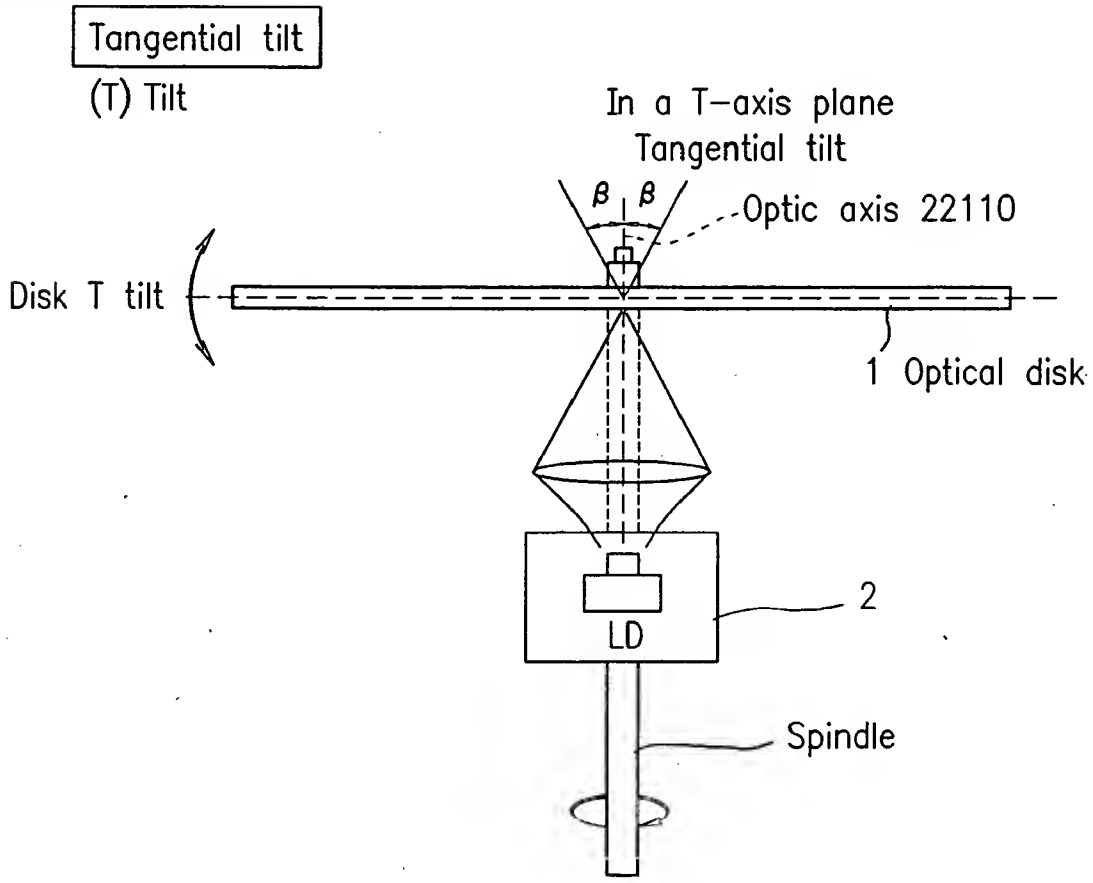


FIG. 25

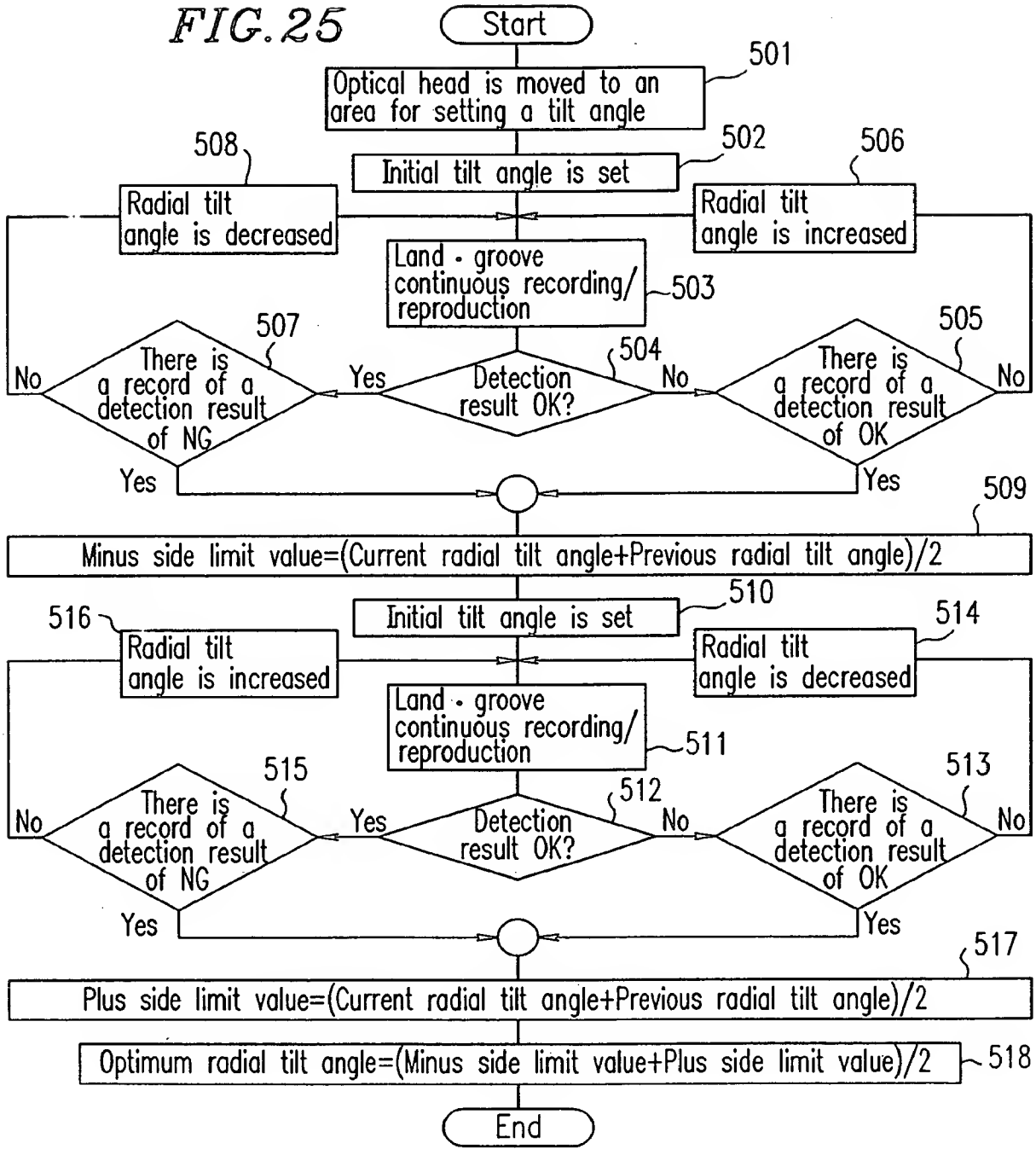

Start
Optical head is moved to an area for setting a tilt angle
501
Initial tilt angle is set
502
508
Radial tilt angle is decreased
506
Radial tilt angle is increased
Land · groove continuous recording/ reproduction
503
507
There is a record of a detection result of NG
No
Yes
504
Detection result OK?
No
505
There is a record of a detection result of OK
No
Yes
Yes
509
Minus side limit value=(Current radial tilt angle+Previous radial tilt angle)/2
Initial tilt angle is set
510
516
Radial tilt angle is increased
514
Radial tilt angle is decreased
Land · groove continuous recording/ reproduction
511
515
There is a record of a detection result of NG
No
Yes
512
Detection result OK?
No
513
There is a record of a detection result of OK
No
Yes
Yes
517
Plus side limit value=(Current radial tilt angle+Previous radial tilt angle)/2
Optimum radial tilt angle=(Minus side limit value+Plus side limit value)/2
518
End

FIG. 26A

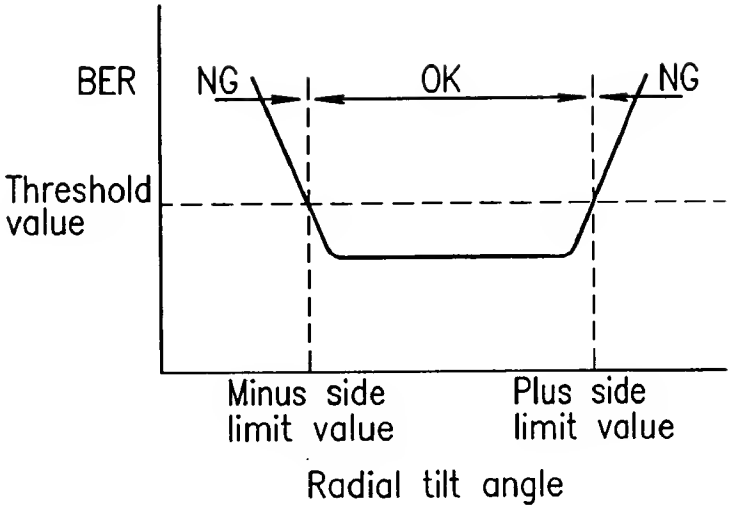


FIG. 26B

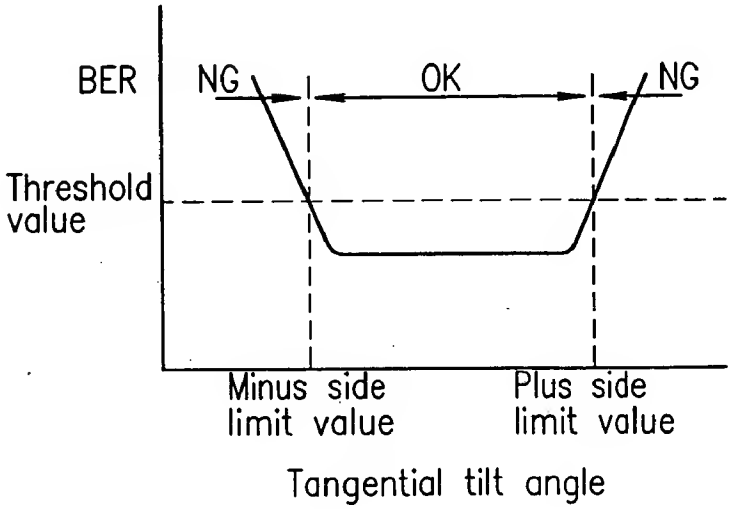


FIG. 27

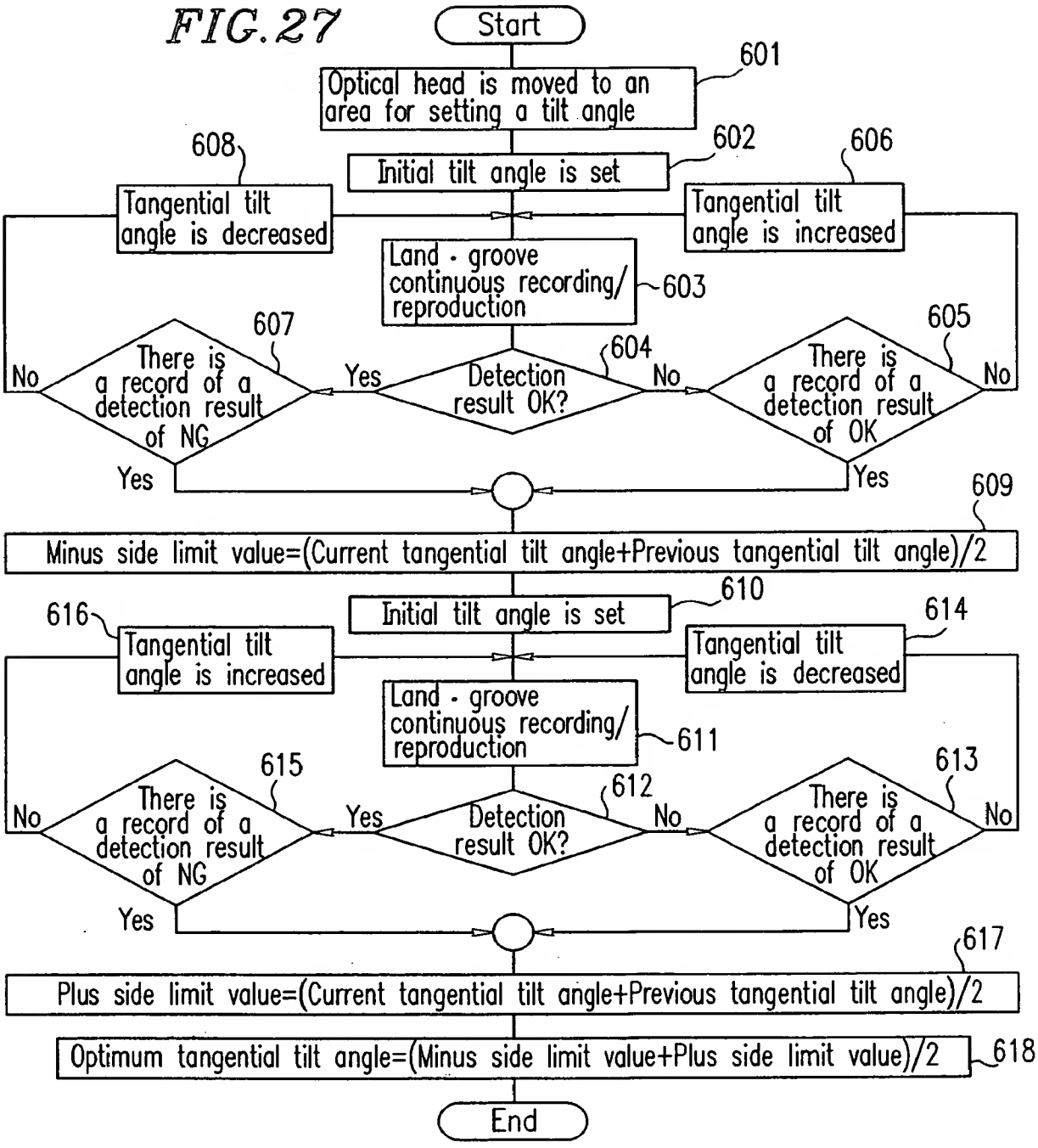

Start
Optical head is moved to an area for setting a tilt angle
601
Initial tilt angle is set
602
608
Tangential tilt angle is decreased
606
Tangential tilt angle is increased
Land - groove continuous recording/ reproduction
603
607
There is a record of a detection result of NG
No
Yes
604
Detection result OK?
No
605
There is a record of a detection result of OK
No
Yes
Yes
609
Minus side limit value=(Current tangential tilt angle+Previous tangential tilt angle)/2
610
Initial tilt angle is set
616
Tangential tilt angle is increased
614
Tangential tilt angle is decreased
Land - groove continuous recording/ reproduction
611
615
There is a record of a detection result of NG
No
Yes
612
Detection result OK?
No
613
There is a record of a detection result of OK
No
Yes
Yes
617
Plus side limit value=(Current tangential tilt angle+Previous tangential tilt angle)/2
Optimum tangential tilt angle=(Minus side limit value+Plus side limit value)/2
618
End

FIG.28

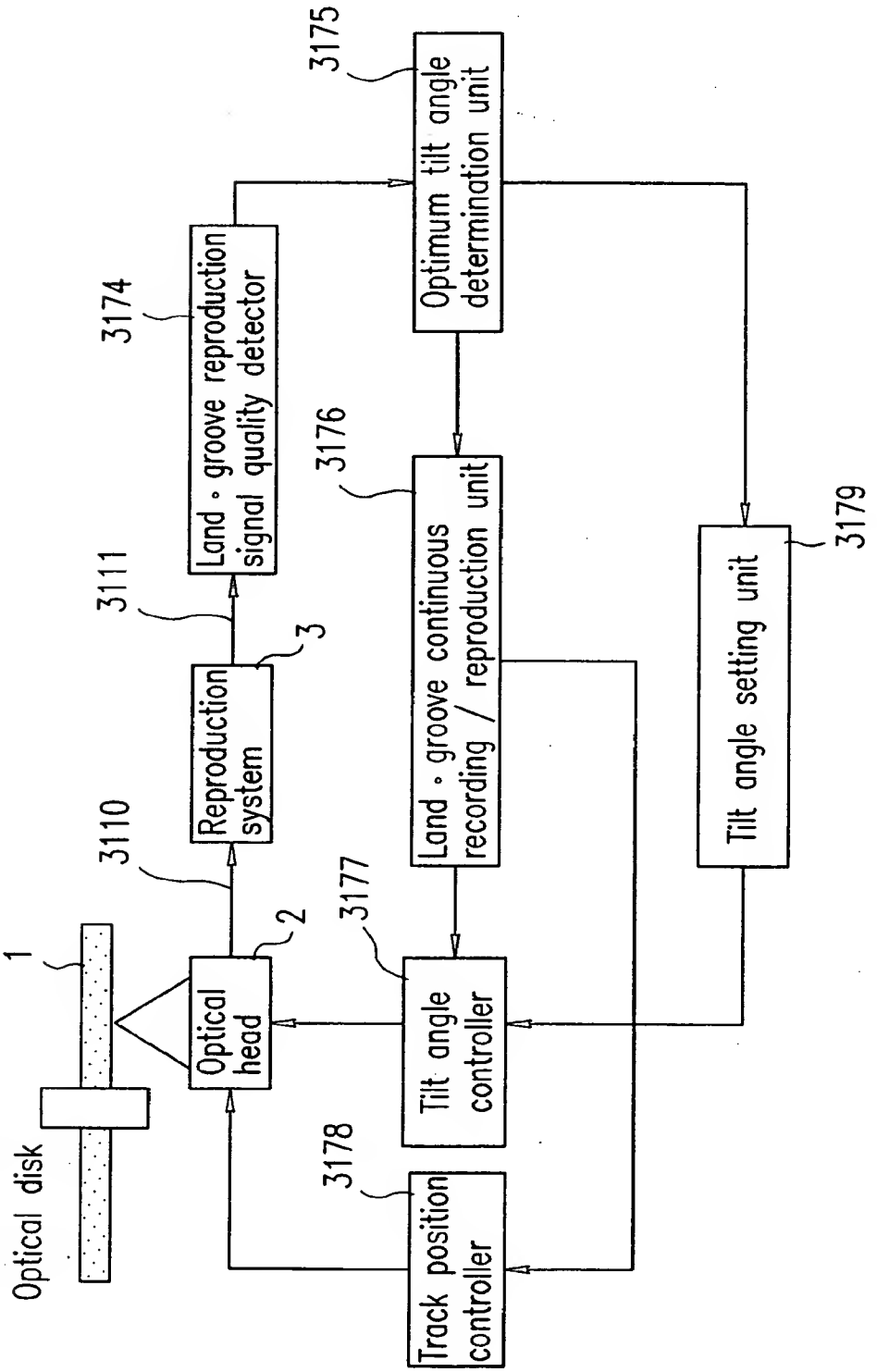

Optical disk
1
Optical head
2
Reproduction system
3
Land・groove reproduction signal quality detector
3174
Optimum tilt angle determination unit
3175
Land・groove continuous recording / reproduction unit
3176
Tilt angle controller
3177
Track position controller
3178
Tilt angle setting unit
3179
3110
3111

FIG. 29

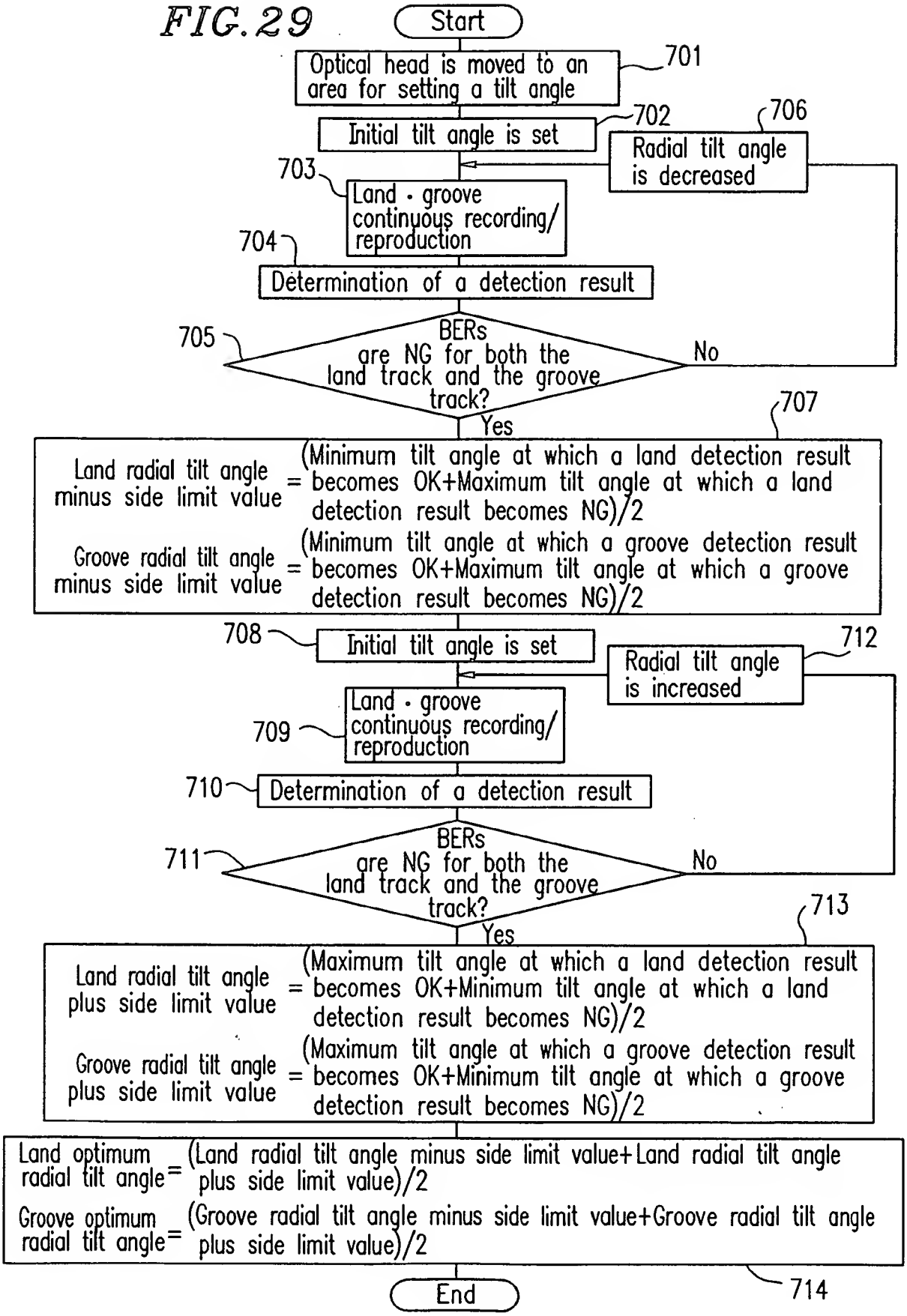

Start
Optical head is moved to an area for setting a tilt angle
701
Initial tilt angle is set
702
Radial tilt angle is decreased
706
703
Land · groove continuous recording/ reproduction
704
Determination of a detection result
705
BERs are NG for both the land track and the groove track?
No
Yes
707
Land radial tilt angle minus side limit value = (Minimum tilt angle at which a land detection result becomes OK+Maximum tilt angle at which a land detection result becomes NG)/2
Groove radial tilt angle minus side limit value = (Minimum tilt angle at which a groove detection result becomes OK+Maximum tilt angle at which a groove detection result becomes NG)/2
708
Initial tilt angle is set
712
Radial tilt angle is increased
709
Land · groove continuous recording/ reproduction
710
Determination of a detection result
711
BERs are NG for both the land track and the groove track?
No
Yes
713
Land radial tilt angle plus side limit value = (Maximum tilt angle at which a land detection result becomes OK+Minimum tilt angle at which a land detection result becomes NG)/2
Groove radial tilt angle plus side limit value = (Maximum tilt angle at which a groove detection result becomes OK+Minimum tilt angle at which a groove detection result becomes NG)/2
Land optimum radial tilt angle = (Land radial tilt angle minus side limit value+Land radial tilt angle plus side limit value)/2
Groove optimum radial tilt angle = (Groove radial tilt angle minus side limit value+Groove radial tilt angle plus side limit value)/2
End
714

FIG. 30

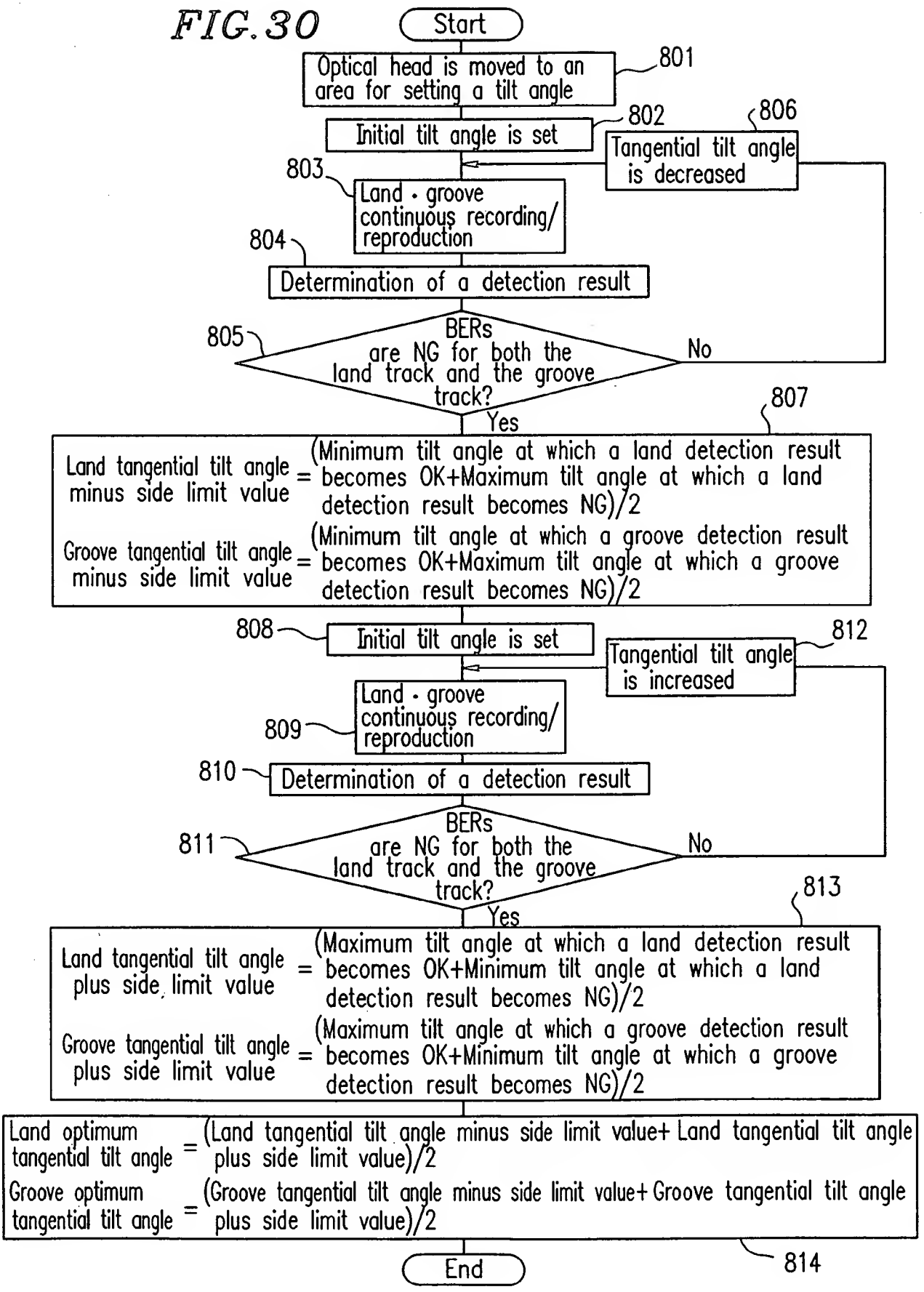

Start
Optical head is moved to an area for setting a tilt angle
801
Initial tilt angle is set
802
806
Tangential tilt angle is decreased
803
Land · groove continuous recording/ reproduction
804
Determination of a detection result
805
BERs are NG for both the land track and the groove track?
No
Yes
807
Land tangential tilt angle minus side limit value = (Minimum tilt angle at which a land detection result becomes OK+Maximum tilt angle at which a land detection result becomes NG)/2
Groove tangential tilt angle minus side limit value = (Minimum tilt angle at which a groove detection result becomes OK+Maximum tilt angle at which a groove detection result becomes NG)/2
808
Initial tilt angle is set
812
Tangential tilt angle is increased
809
Land · groove continuous recording/ reproduction
810
Determination of a detection result
811
BERs are NG for both the land track and the groove track?
No
Yes
813
Land tangential tilt angle plus side limit value = (Maximum tilt angle at which a land detection result becomes OK+Minimum tilt angle at which a land detection result becomes NG)/2
Groove tangential tilt angle plus side limit value = (Maximum tilt angle at which a groove detection result becomes OK+Minimum tilt angle at which a groove detection result becomes NG)/2
Land optimum tangential tilt angle = (Land tangential tilt angle minus side limit value+ Land tangential tilt angle plus side limit value)/2
Groove optimum tangential tilt angle = (Groove tangential tilt angle minus side limit value+ Groove tangential tilt angle plus side limit value)/2
814
End

FIG. 31A

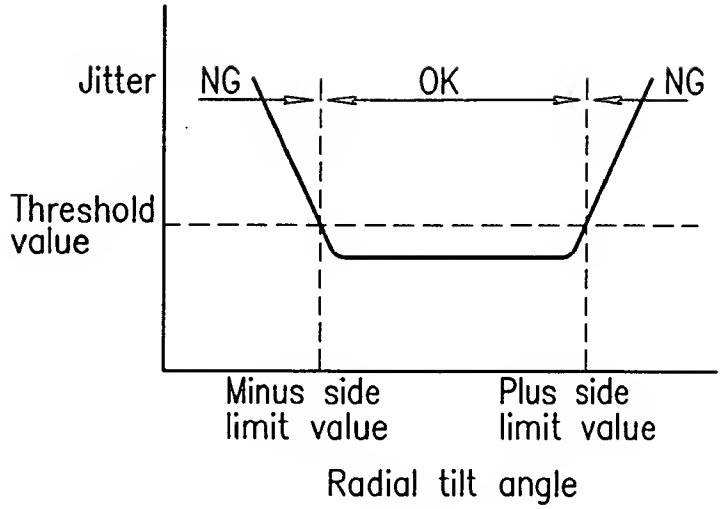


FIG. 31B

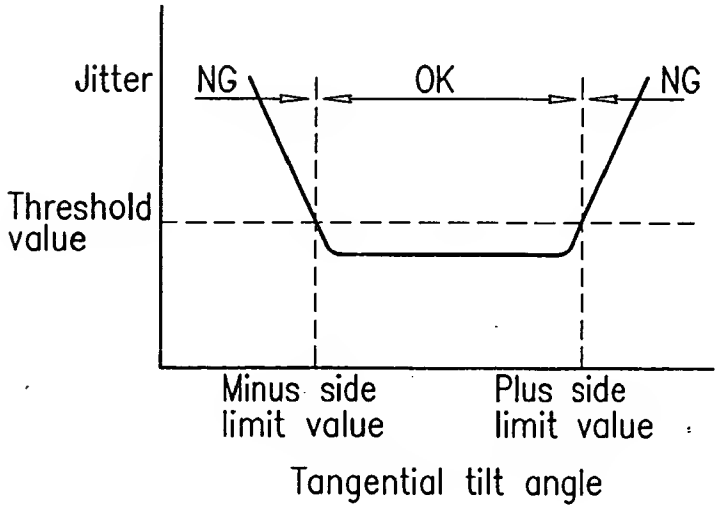


FIG. 32A

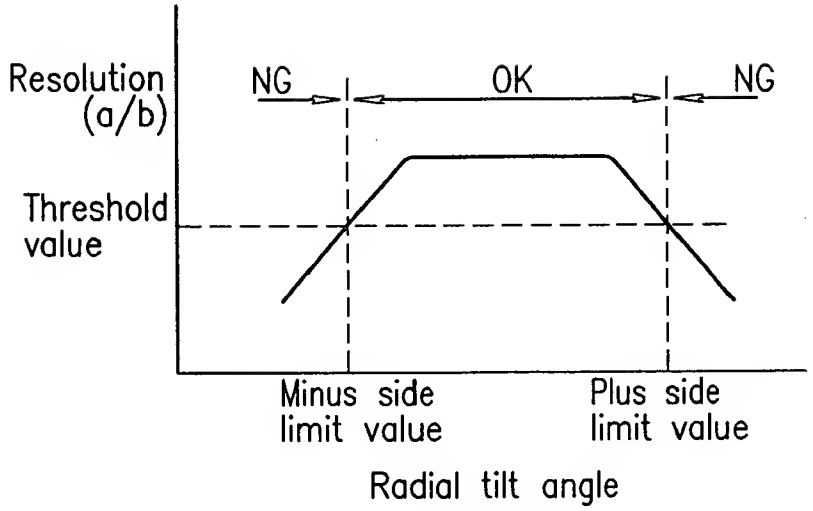


FIG. 32B

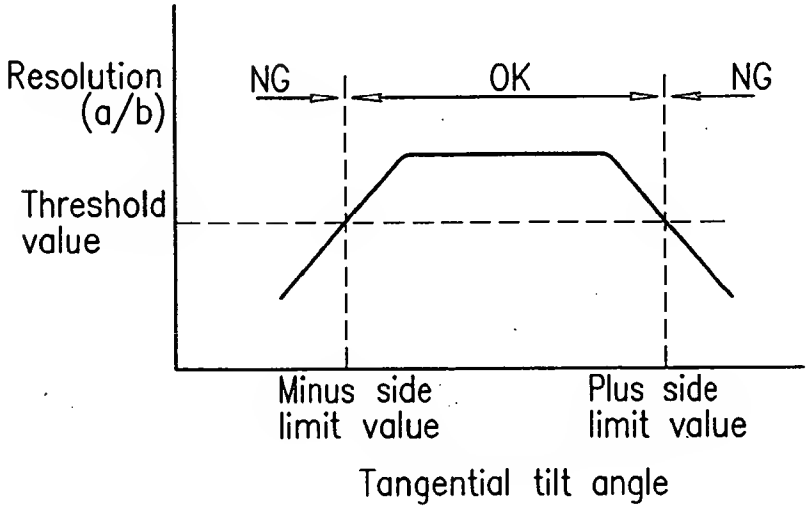


FIG. 33A

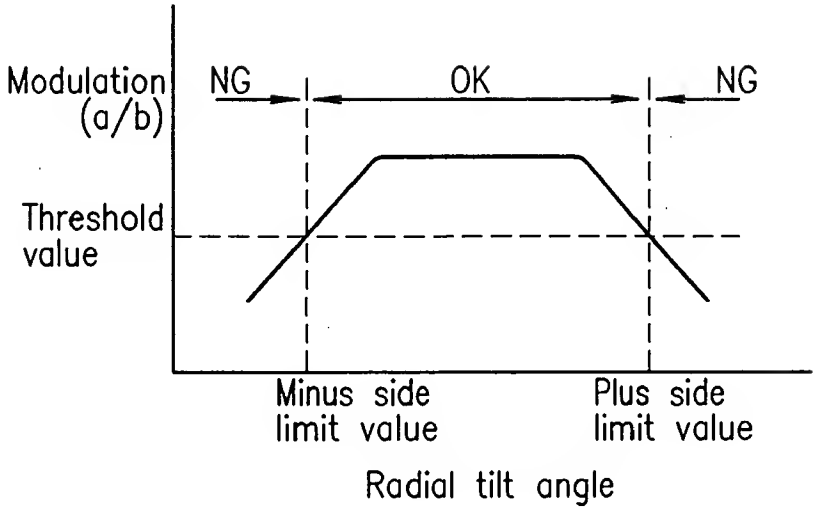


FIG. 33B

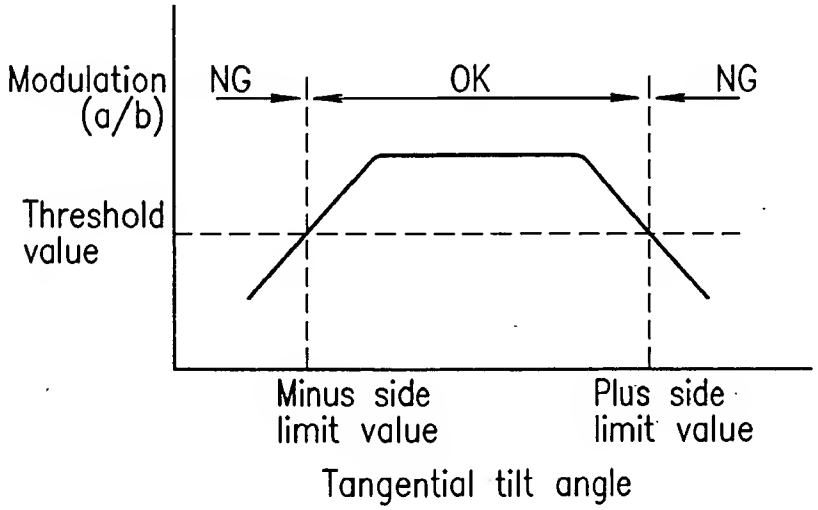


FIG. 34A

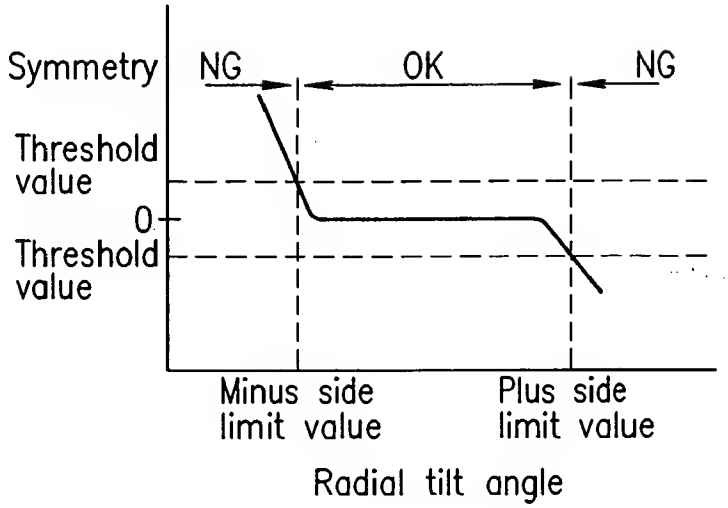


FIG. 34B

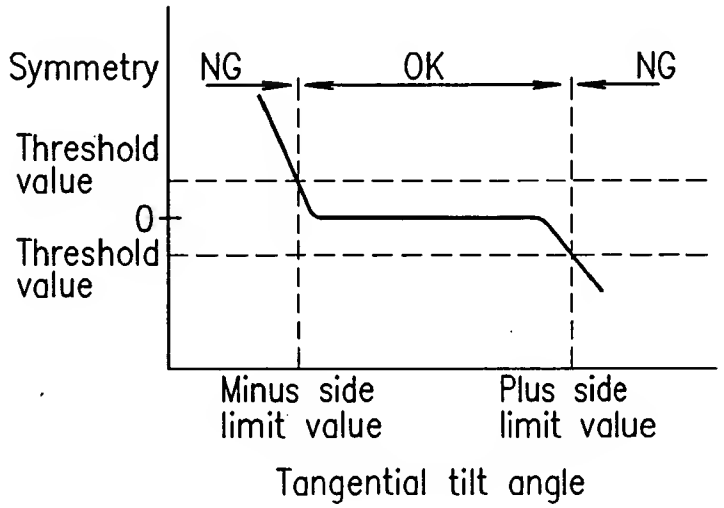


FIG. 35

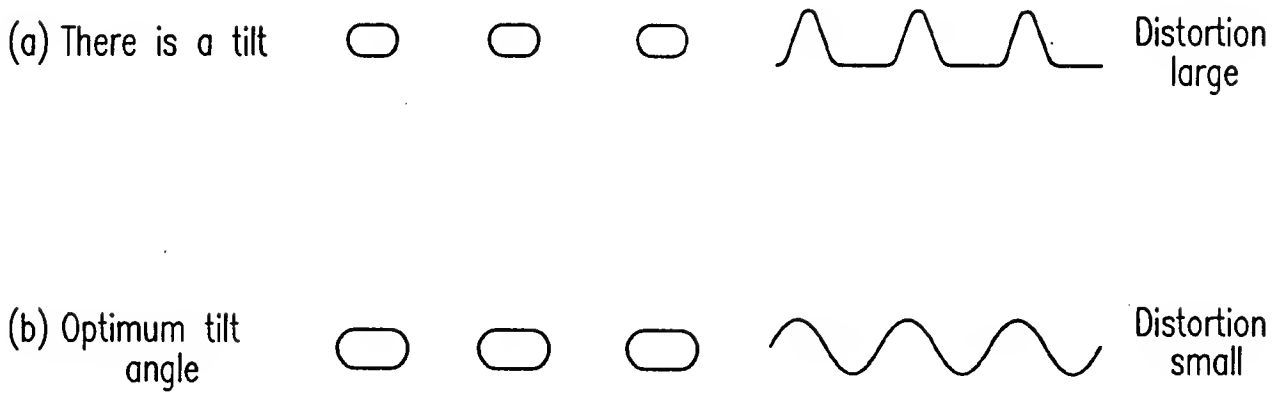

(a) There is a tilt
Distortion large
(b) Optimum tilt angle
Distortion small

FIG. 36A

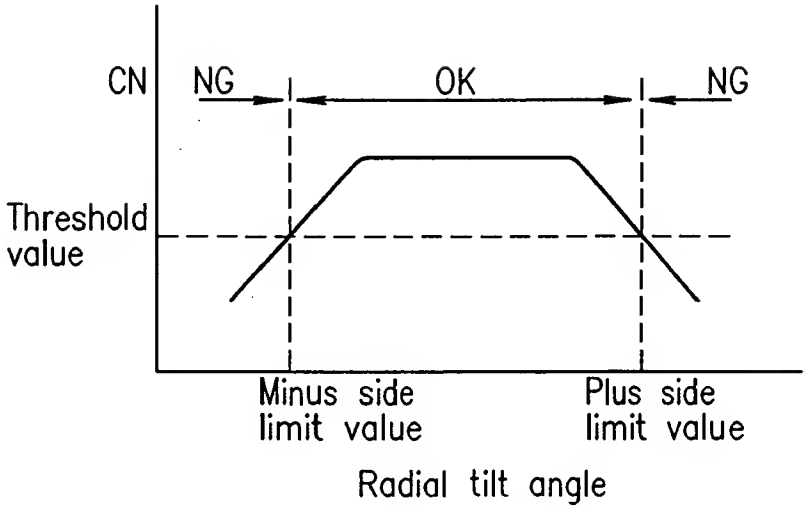


FIG. 36B

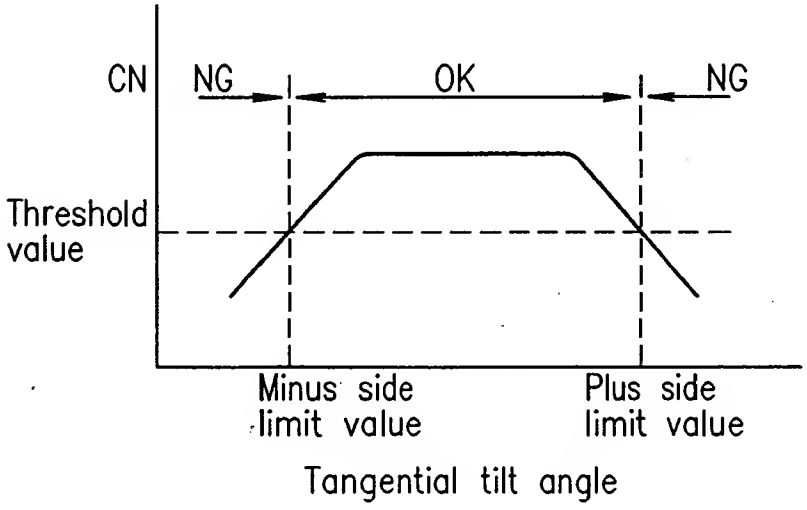


FIG. 37

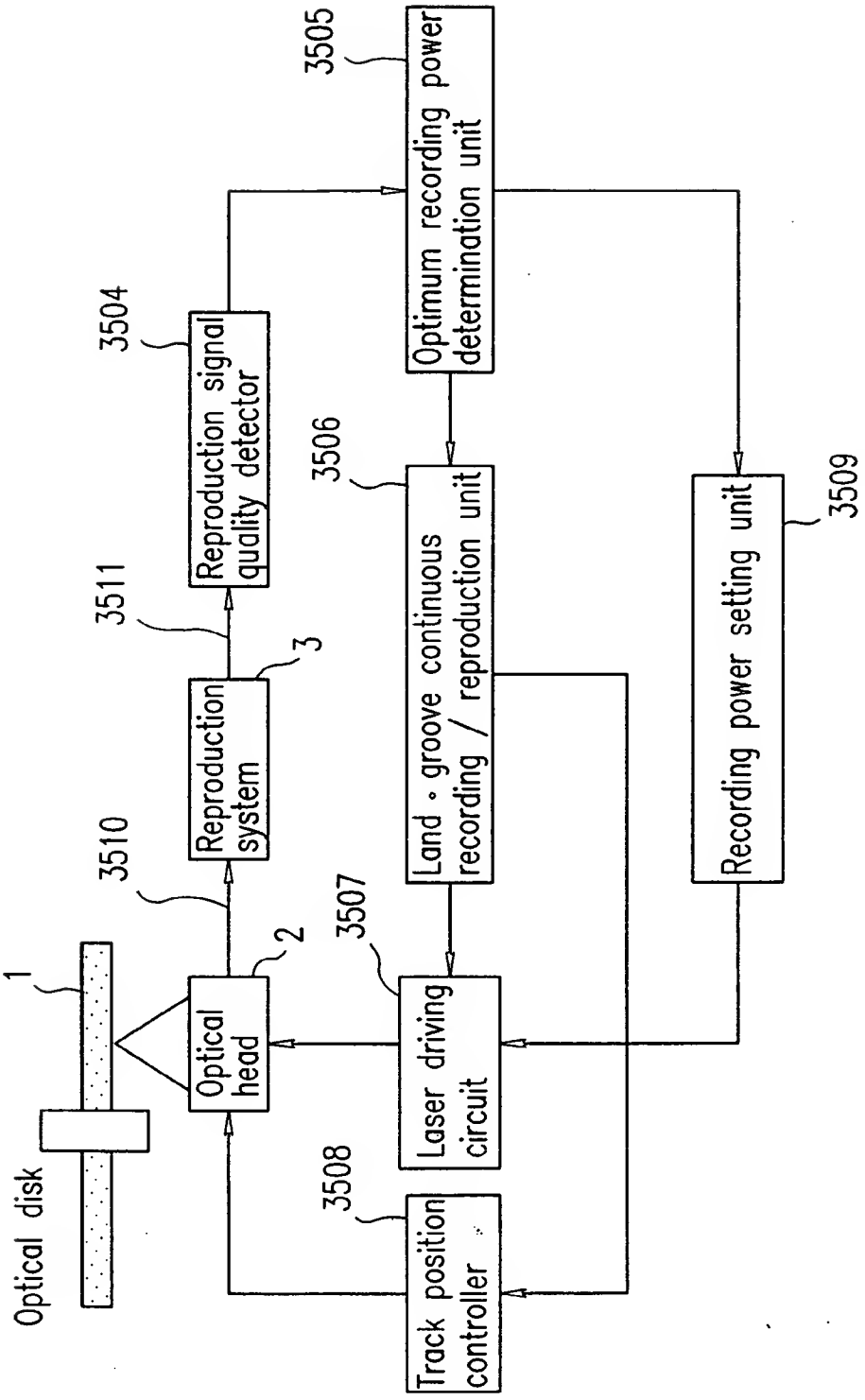

Optical disk
1
Optical head
2
Reproduction system
3
Reproduction signal quality detector
3504
Optimum recording power determination unit
3505
Land・groove continuous recording / reproduction unit
3506
Laser driving circuit
3507
Track position controller
3508
Recording power setting unit
3509
3510
3511

FIG. 38

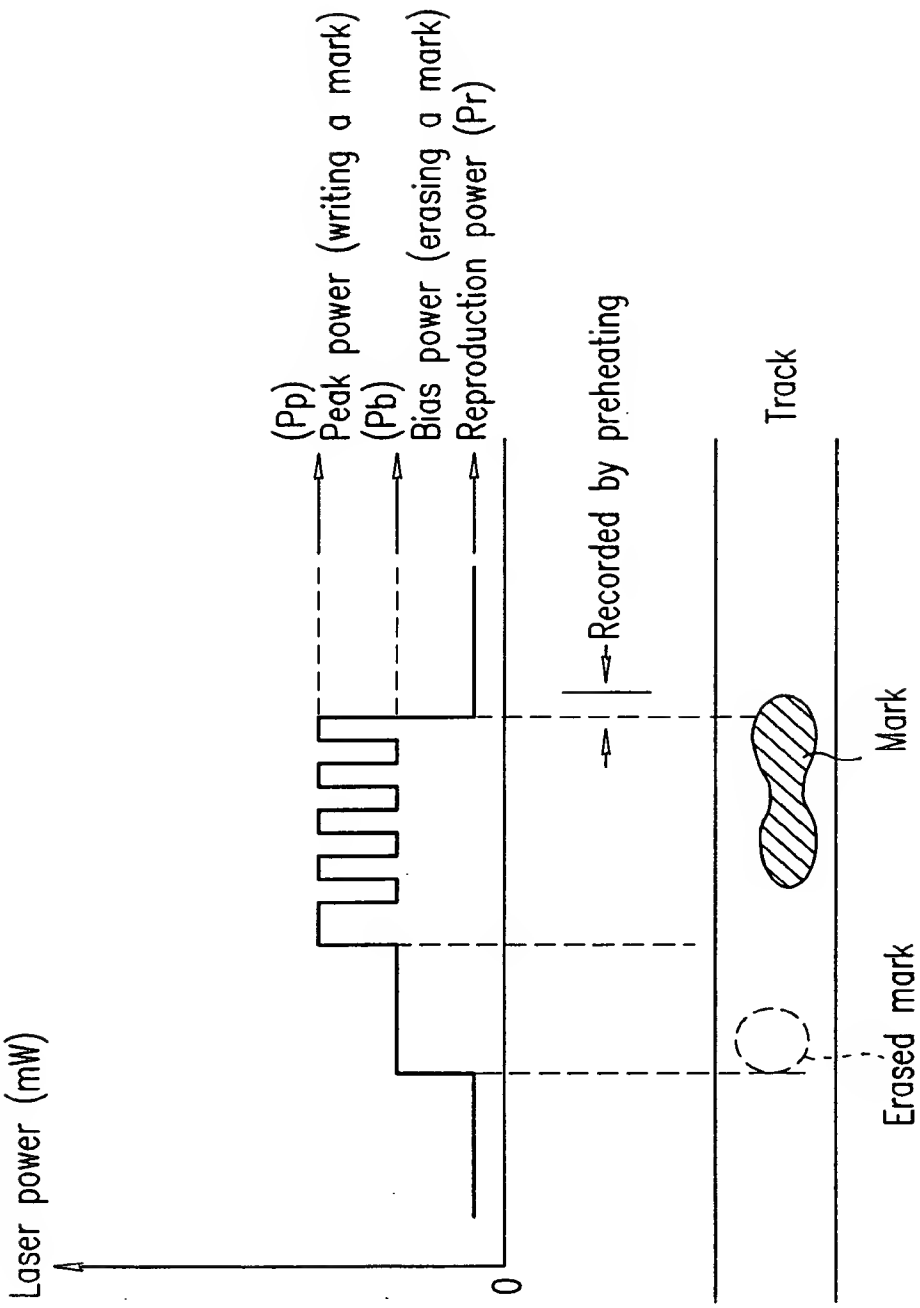

Power
Laser power (mW)
0
(Pp) Peak power (writing a mark)
(Pb) Bias power (erasing a mark)
Reproduction power (Pr)
Recorded by preheating
Track
Mark
Erased mark

FIG. 39

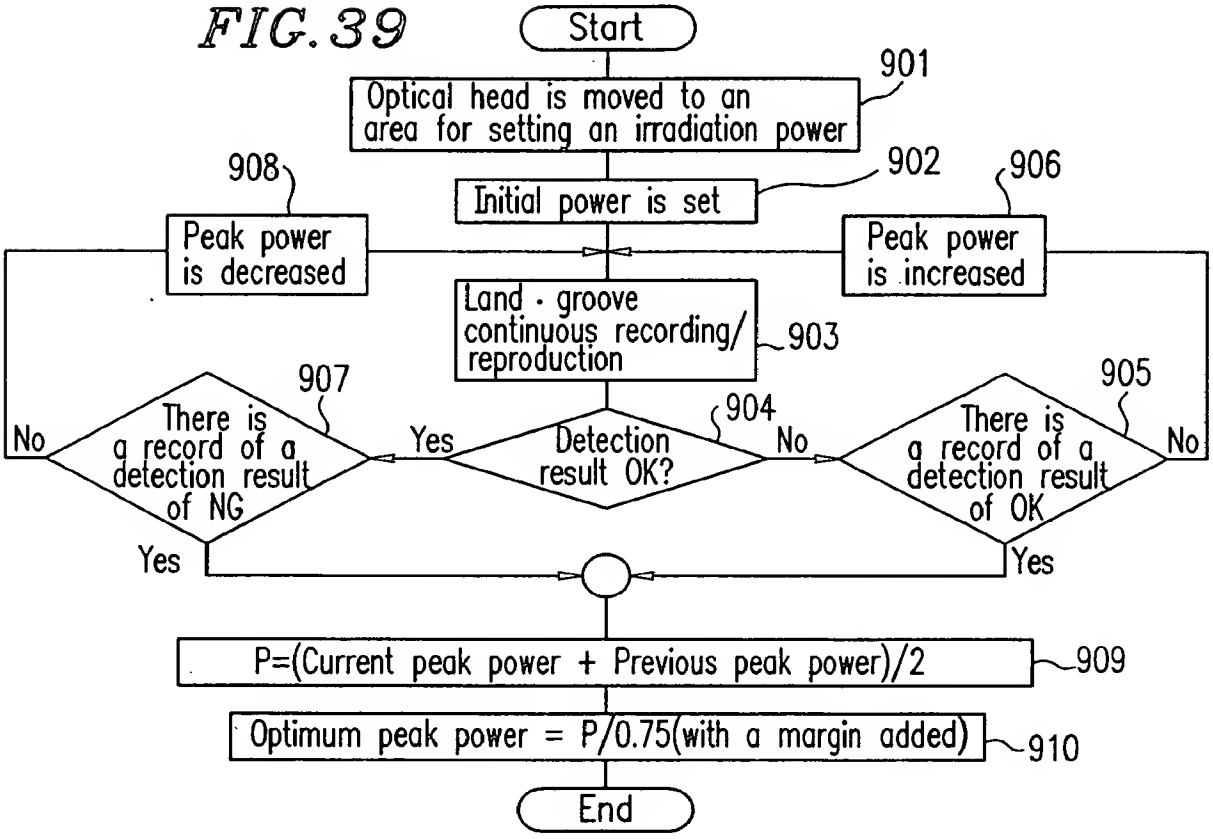

Start
Optical head is moved to an area for setting an irradiation power
901
Initial power is set
902
908
Peak power is decreased
906
Peak power is increased
Land · groove continuous recording/ reproduction
903
907
There is a record of a detection result of NG
No
Yes
904
Detection result OK?
No
905
There is a record of a detection result of OK
No
Yes
Yes
P=(Current peak power + Previous peak power)/2
909
Optimum peak power = P/0.75(with a margin added)
910
End

FIG. 40A

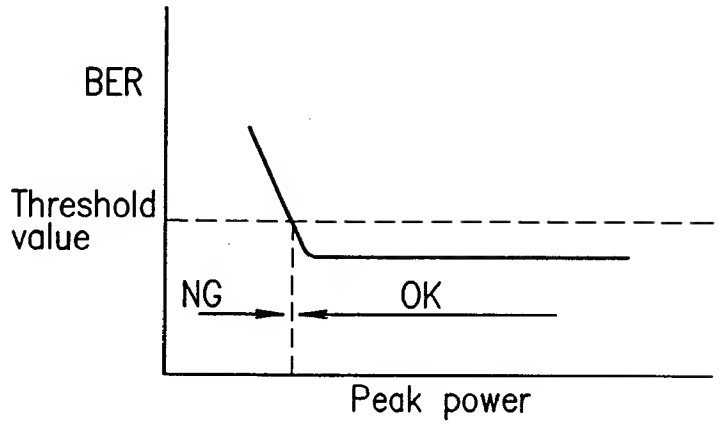


FIG. 40B

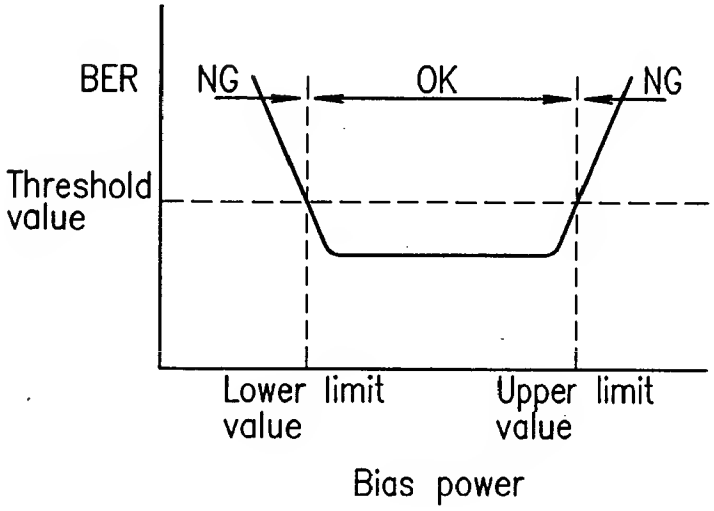


FIG. 41

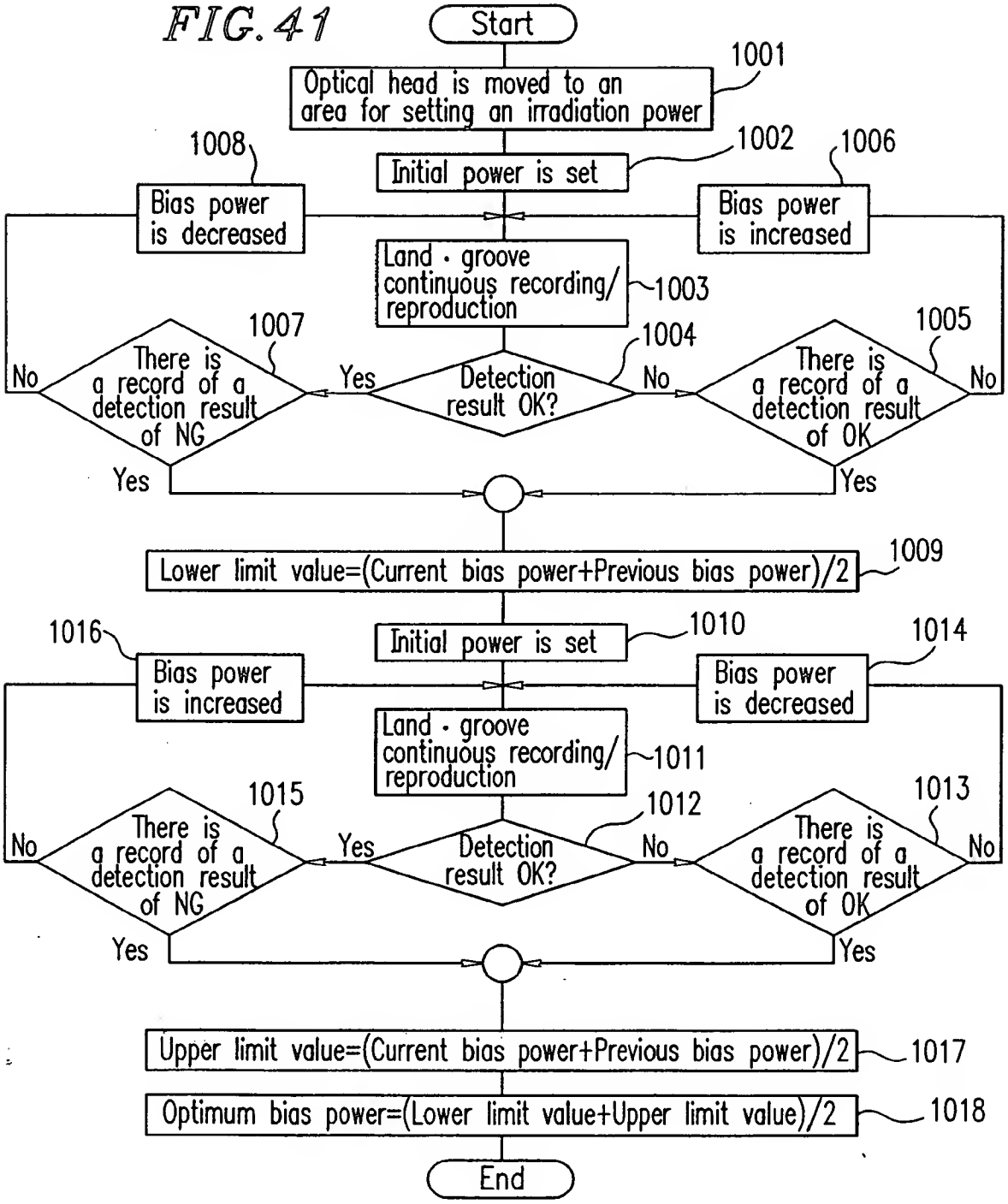

Start
Optical head is moved to an area for setting an irradiation power
1001
Initial power is set
1002
1008
Bias power is decreased
1006
Bias power is increased
Land · groove continuous recording/ reproduction
1003
1007
There is a record of a detection result of NG
1004
Detection result OK?
1005
There is a record of a detection result of OK
No
Yes
Yes
No
No
Yes
Lower limit value=(Current bias power+Previous bias power)/2
1009
1016
Bias power is increased
Initial power is set
1010
1014
Bias power is decreased
Land · groove continuous recording/ reproduction
1011
1015
There is a record of a detection result of NG
1012
Detection result OK?
1013
There is a record of a detection result of OK
No
Yes
Yes
No
No
Yes
Upper limit value=(Current bias power+Previous bias power)/2
1017
Optimum bias power=(Lower limit value+Upper limit value)/2
1018
End

FIG. 42A

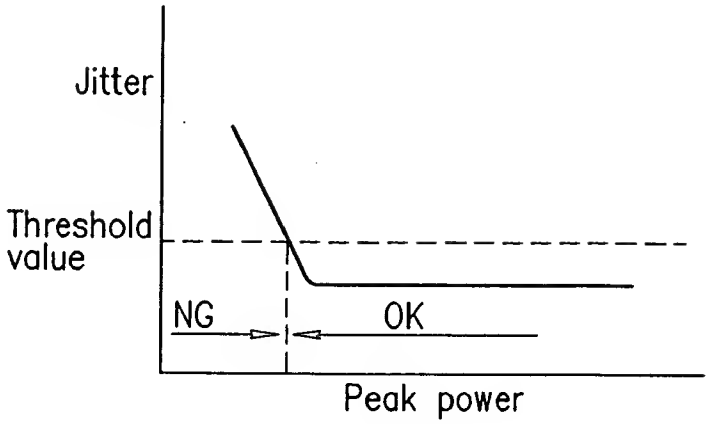


FIG. 42B

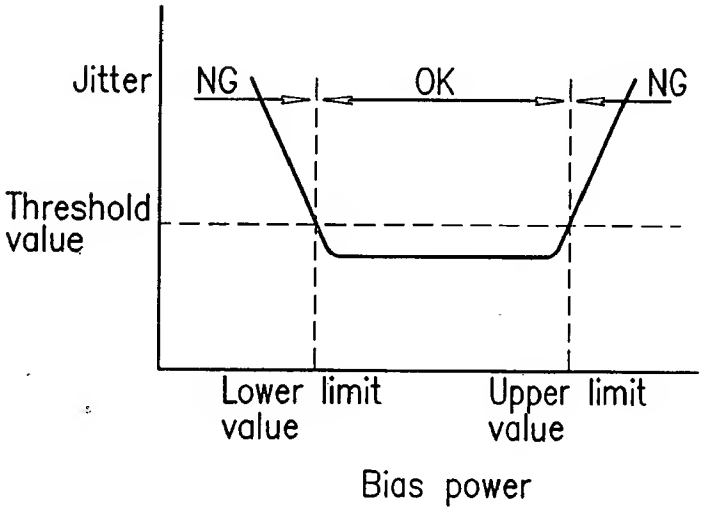


FIG. 43A

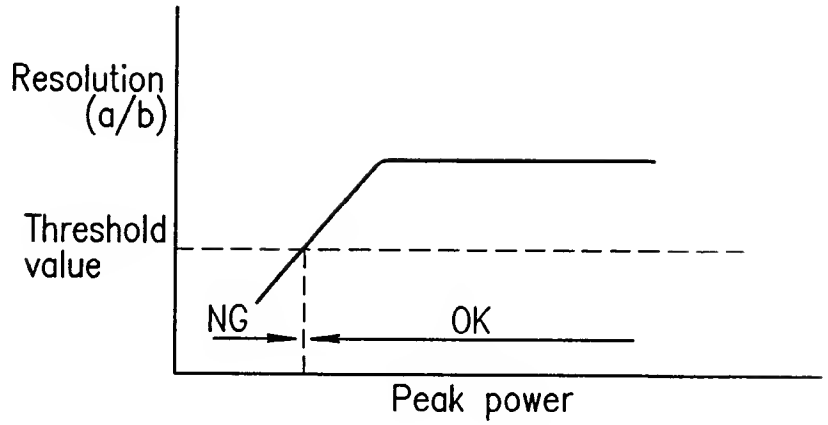


FIG. 43B

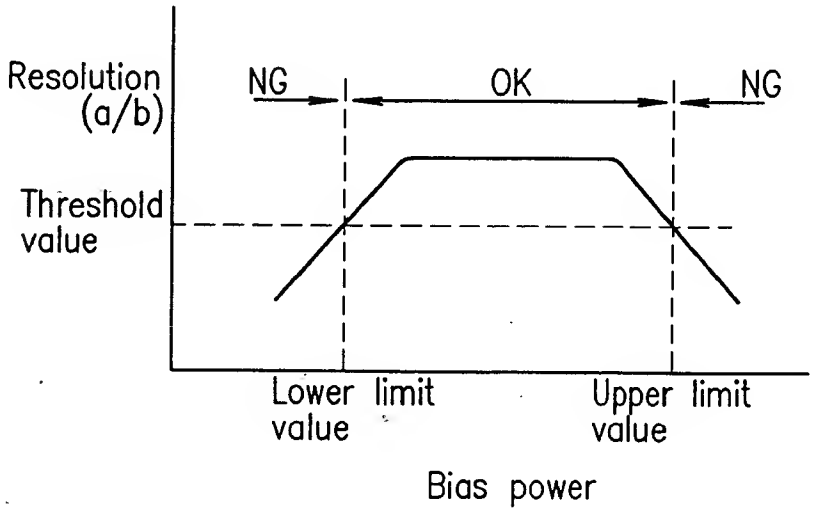


FIG. 44A

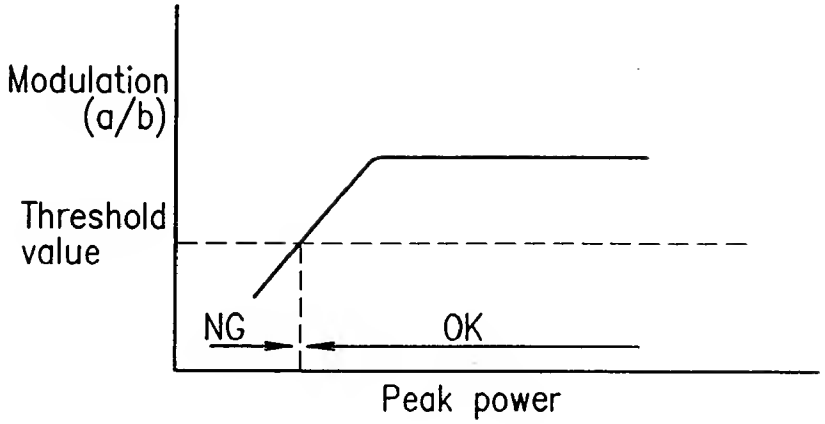


FIG. 44B

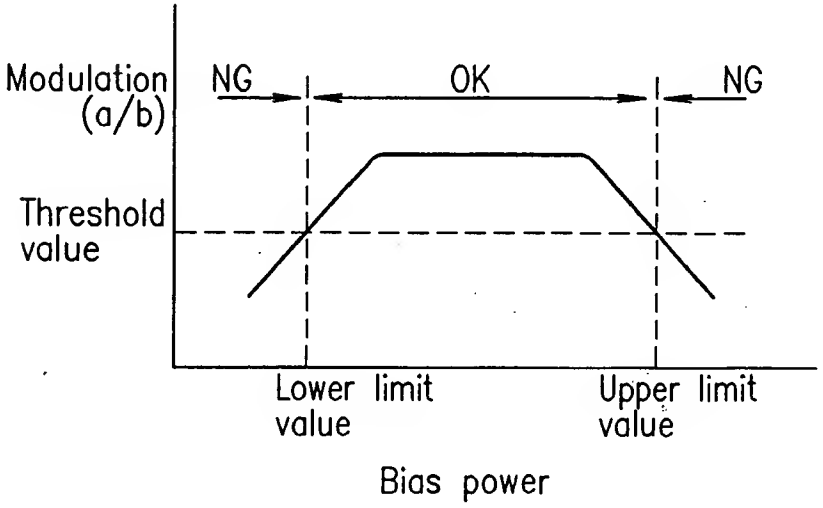


FIG. 45A

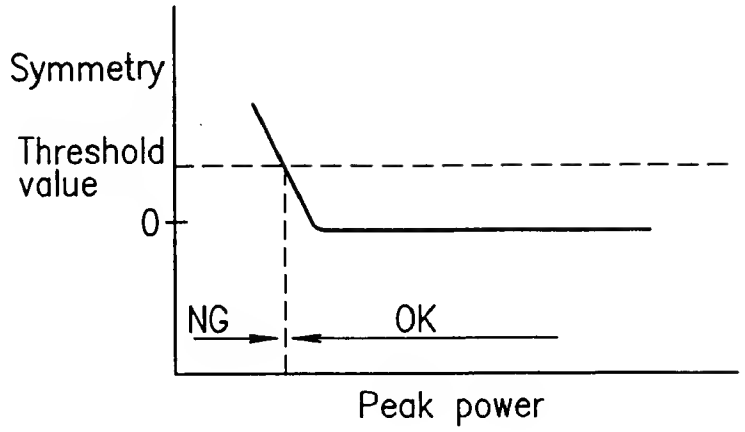


FIG. 45B

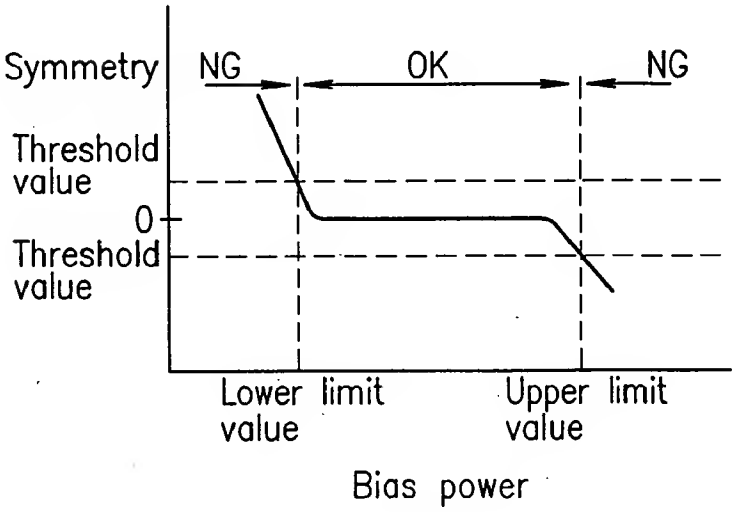


FIG. 46

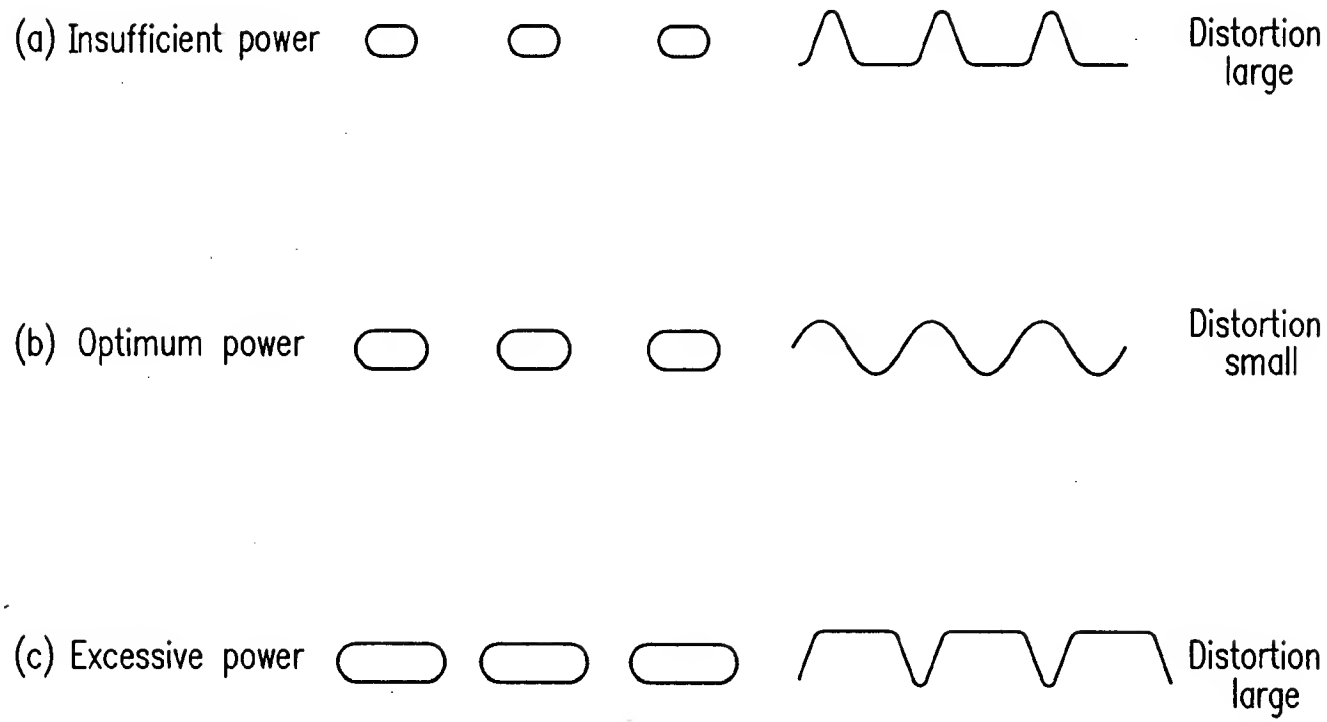


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FIG. 47

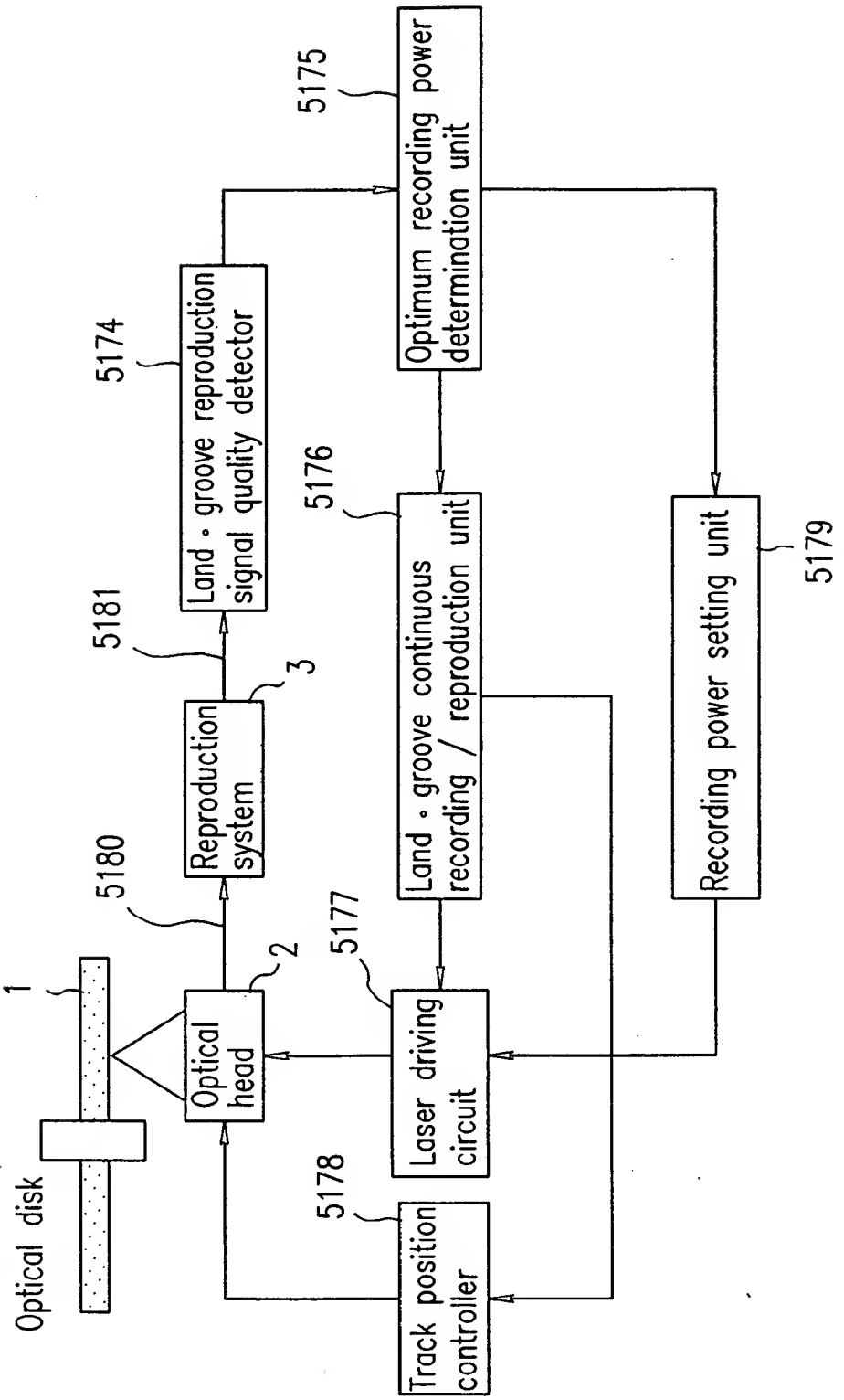

Optical disk
1
Optical head
2
Reproduction system
3
Land • groove reproduction signal quality detector
5174
Optimum recording power determination unit
5175
Land • groove continuous recording / reproduction unit
5176
Laser driving circuit
5177
Track position controller
5178
Recording power setting unit
5179
5180
5181

FIG. 48

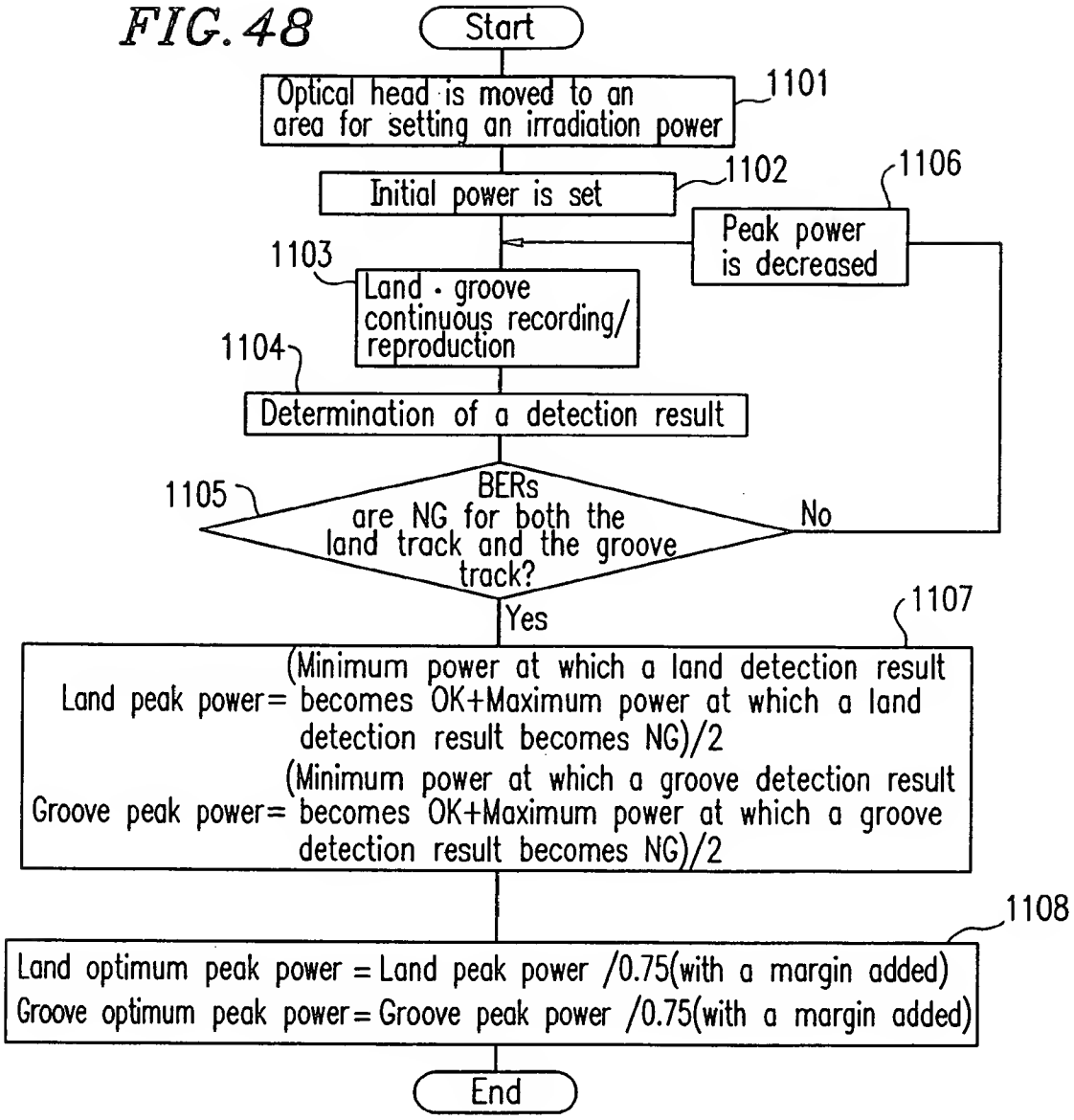

Start
Optical head is moved to an area for setting an irradiation power
1101
Initial power is set
1102
1106
Peak power is decreased
1103
Land · groove continuous recording/ reproduction
1104
Determination of a detection result
1105
BERs are NG for both the land track and the groove track?
No
Yes
1107
Land peak power= (Minimum power at which a land detection result becomes OK+Maximum power at which a land detection result becomes NG)/2
Groove peak power= (Minimum power at which a groove detection result becomes OK+Maximum power at which a groove detection result becomes NG)/2
1108
Land optimum peak power = Land peak power /0.75(with a margin added)
Groove optimum peak power= Groove peak power /0.75(with a margin added)
End

FIG. 49

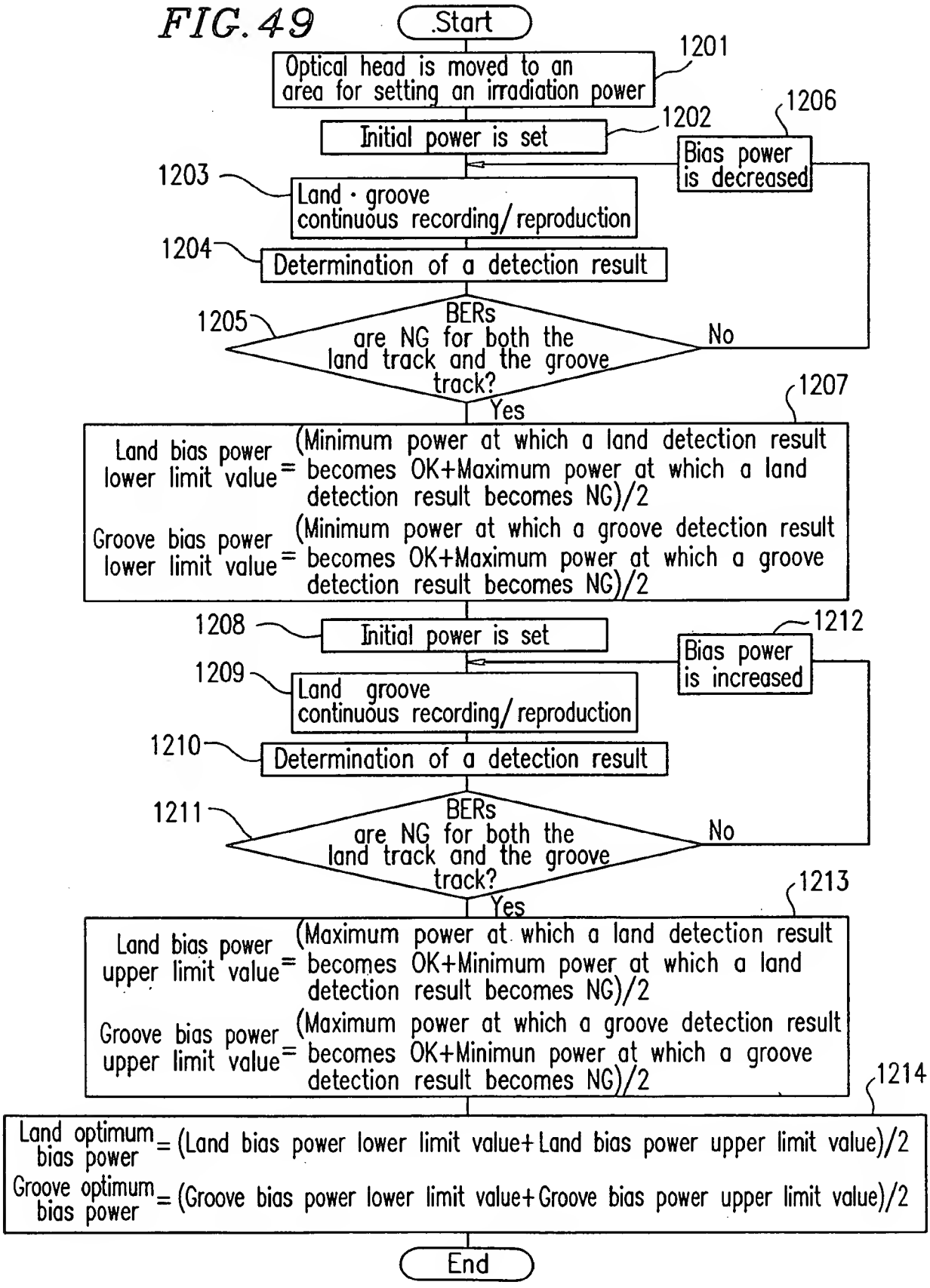

Start
1201
Optical head is moved to an area for setting an irradiation power
1202
Initial power is set
1206
Bias power is decreased
1203
Land · groove continuous recording/reproduction
1204
Determination of a detection result
1205
BERs are NG for both the land track and the groove track?
No
Yes
1207
Land bias power lower limit value = (Minimum power at which a land detection result becomes OK+Maximum power at which a land detection result becomes NG)/2
Groove bias power lower limit value = (Minimum power at which a groove detection result becomes OK+Maximum power at which a groove detection result becomes NG)/2
1208
Initial power is set
1212
Bias power is increased
1209
Land groove continuous recording/reproduction
1210
Determination of a detection result
1211
BERs are NG for both the land track and the groove track?
No
Yes
1213
Land bias power upper limit value = (Maximum power at which a land detection result becomes OK+Minimum power at which a land detection result becomes NG)/2
Groove bias power upper limit value = (Maximum power at which a groove detection result becomes OK+Minimun power at which a groove detection result becomes NG)/2
1214
Land optimum bias power = (Land bias power lower limit value+Land bias power upper limit value)/2
Groove optimum bias power = (Groove bias power lower limit value+Groove bias power upper limit value)/2
End

FIG. 50

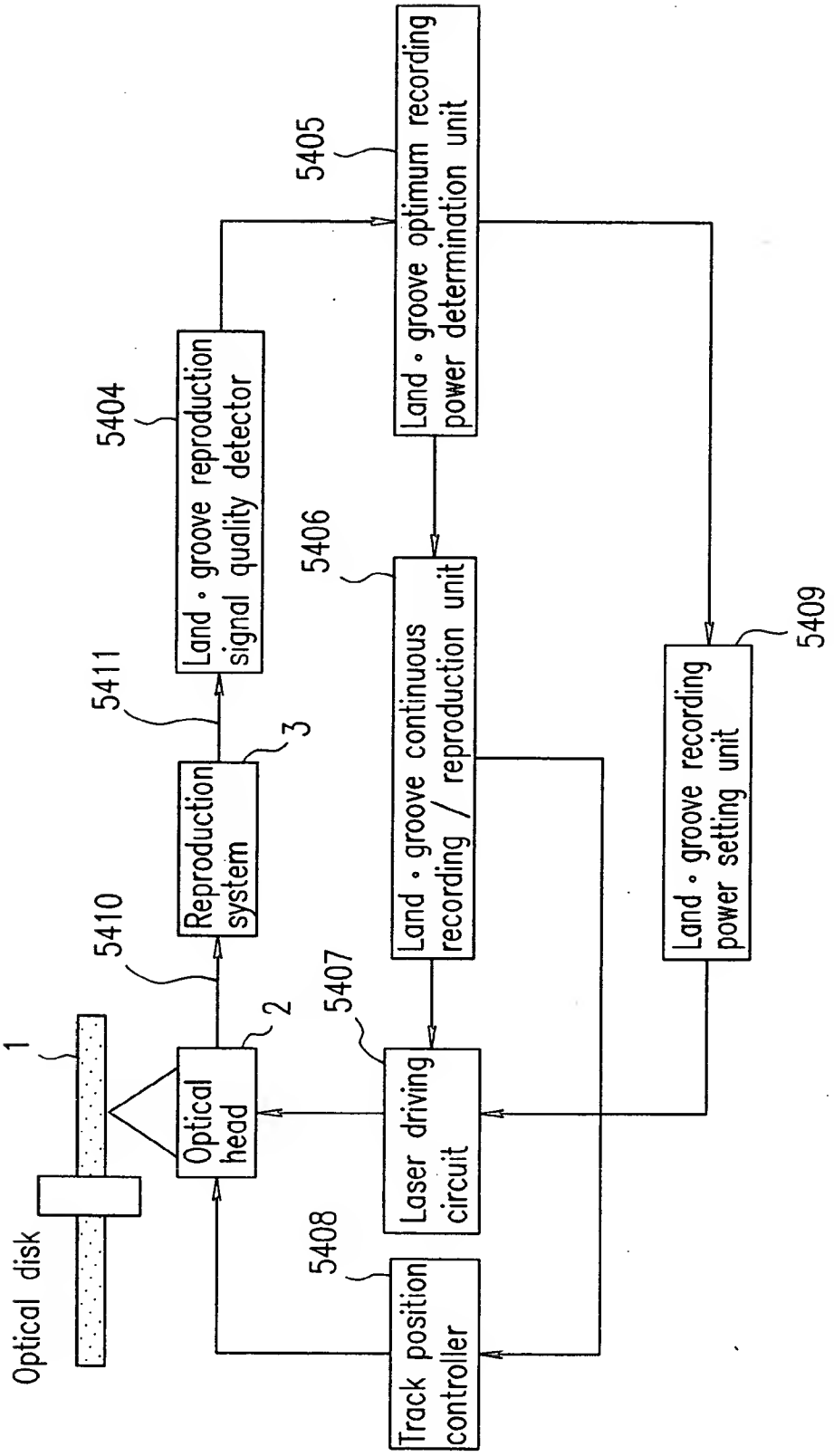

Optical disk
1
Optical head
2
Reproduction system
3
Land • groove reproduction signal quality detector
5404
Land • groove optimum recording power determination unit
5405
Land • groove continuous recording / reproduction unit
5406
Laser driving circuit
5407
Track position controller
5408
Land • groove recording power setting unit
5409
5410
5411

FIG. 51

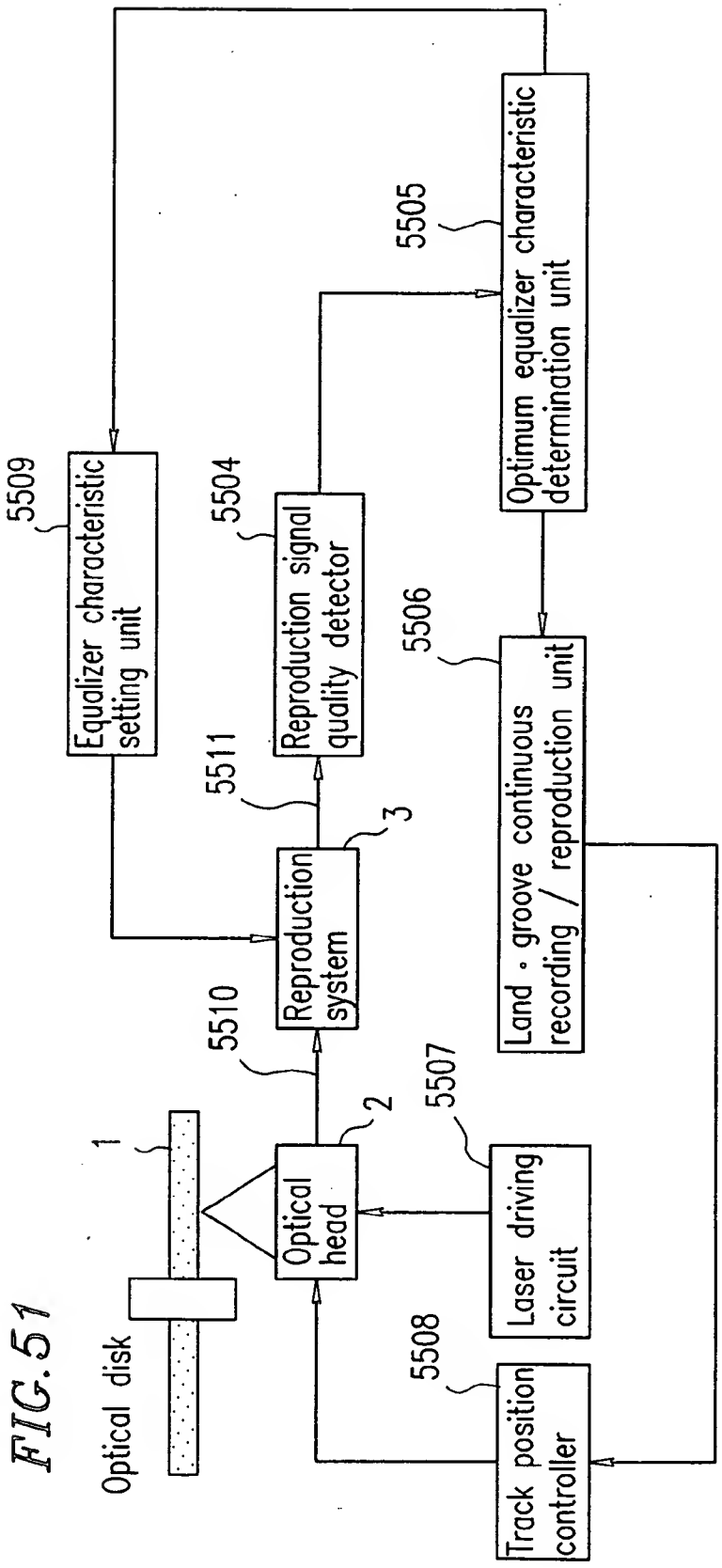

Optical disk
1
Optical head
2
Reproduction system
3
Equalizer characteristic setting unit
5509
Reproduction signal quality detector
5504
Optimum equalizer characteristic determination unit
5505
Land・groove continuous recording / reproduction unit
5506
Laser driving circuit
5507
Track position controller
5508
5510
5511

FIG. 52A

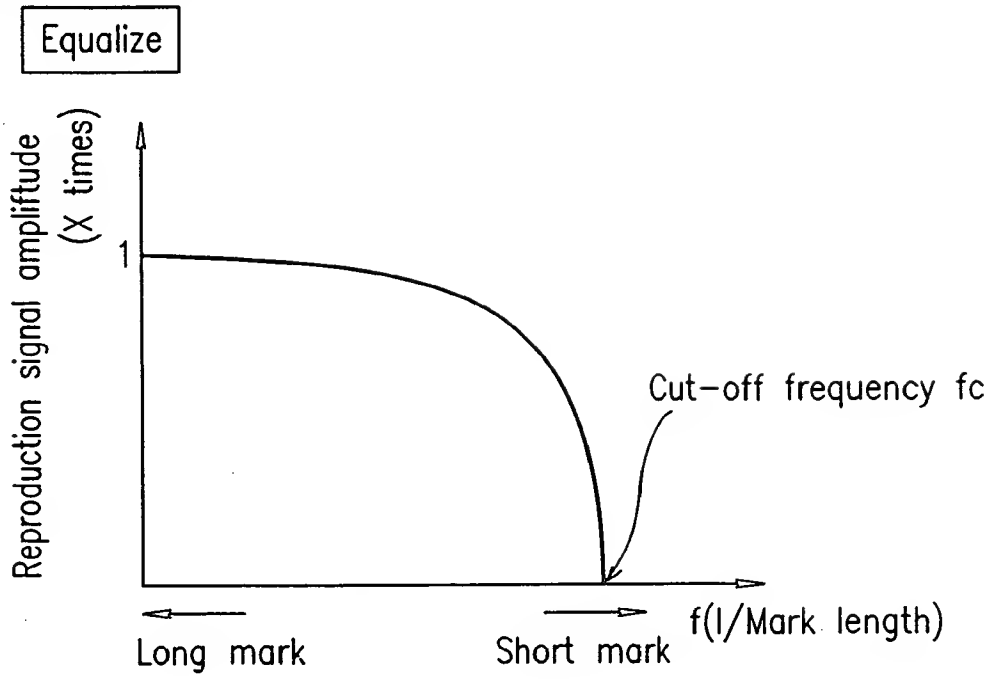


FIG. 52B

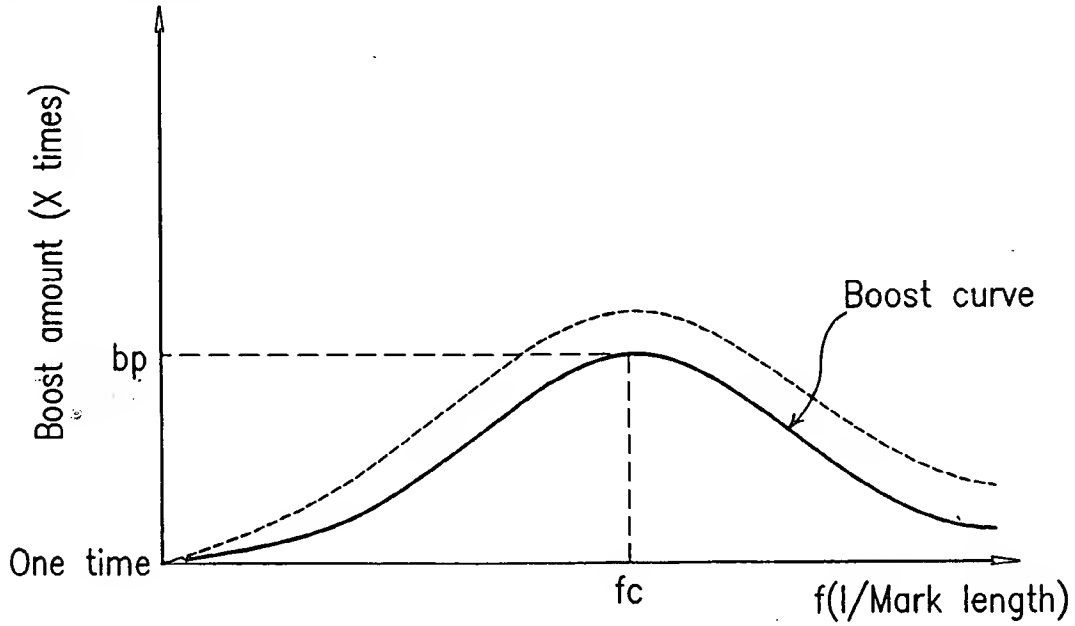


FIG. 53

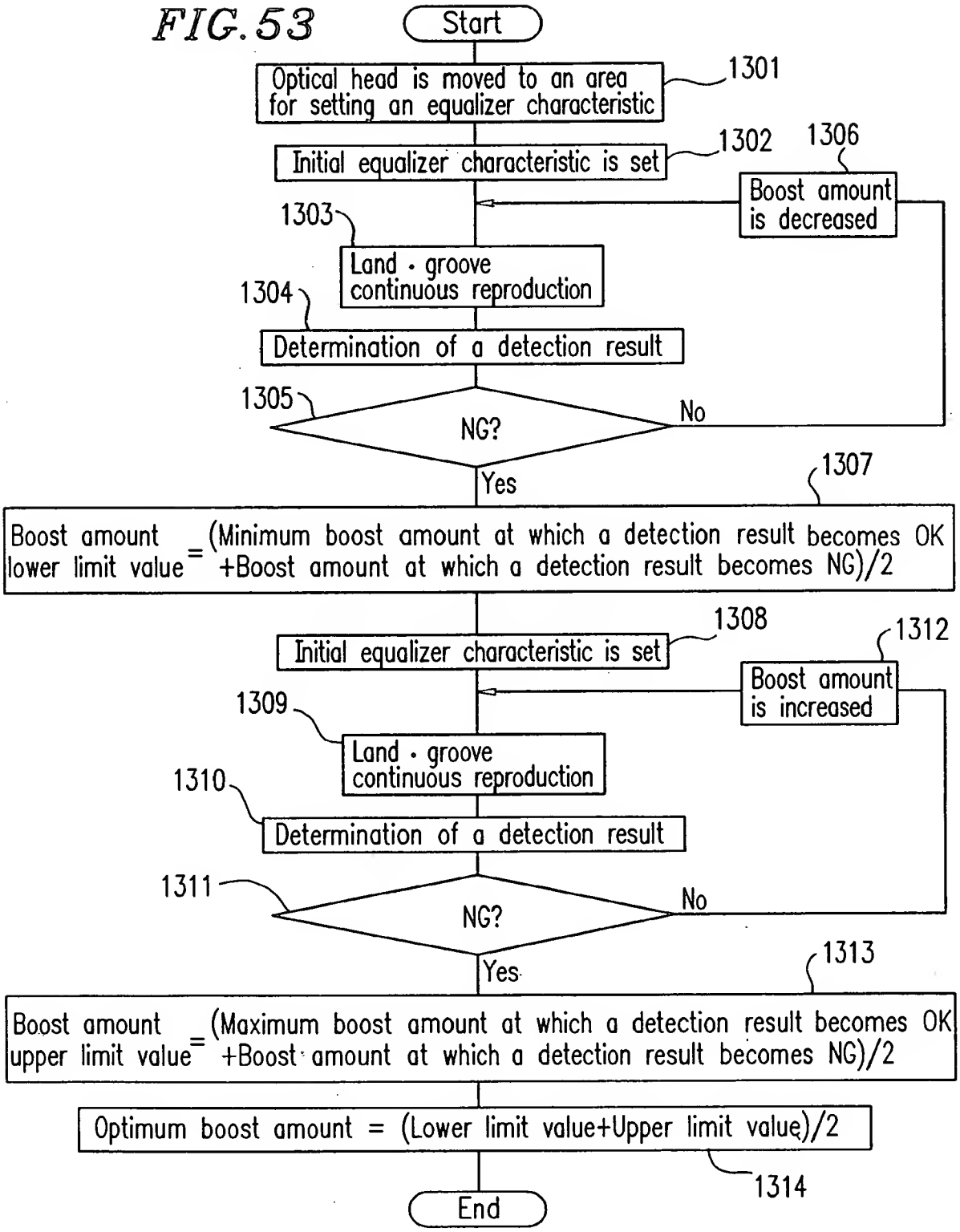

Start
Optical head is moved to an area for setting an equalizer characteristic
1301
Initial equalizer characteristic is set
1302
1306
Boost amount is decreased
1303
Land · groove continuous reproduction
1304
Determination of a detection result
1305
NG?
No
Yes
1307
Boost amount lower limit value = (Minimum boost amount at which a detection result becomes OK +Boost amount at which a detection result becomes NG)/2
Initial equalizer characteristic is set
1308
1312
Boost amount is increased
1309
Land · groove continuous reproduction
1310
Determination of a detection result
1311
NG?
No
Yes
1313
Boost amount upper limit value = (Maximum boost amount at which a detection result becomes OK +Boost amount at which a detection result becomes NG)/2
Optimum boost amount = (Lower limit value+Upper limit value)/2
1314
End

FIG. 54A

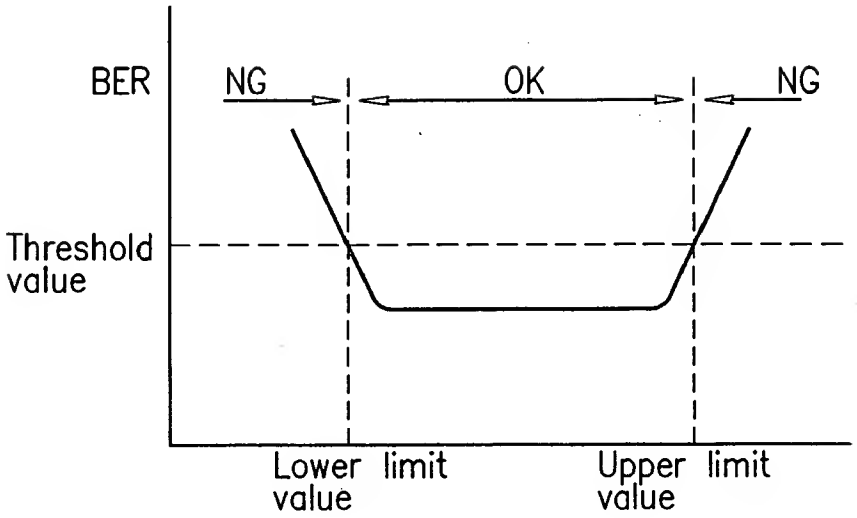


FIG. 54B

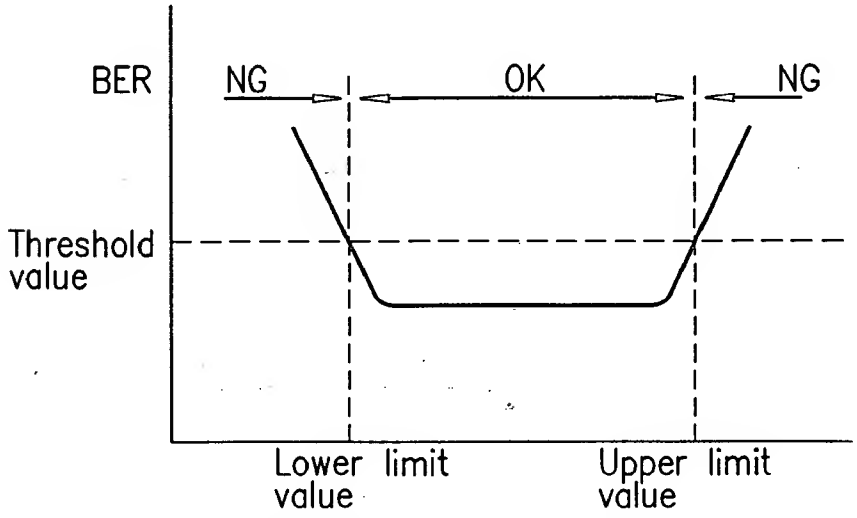


FIG. 55A

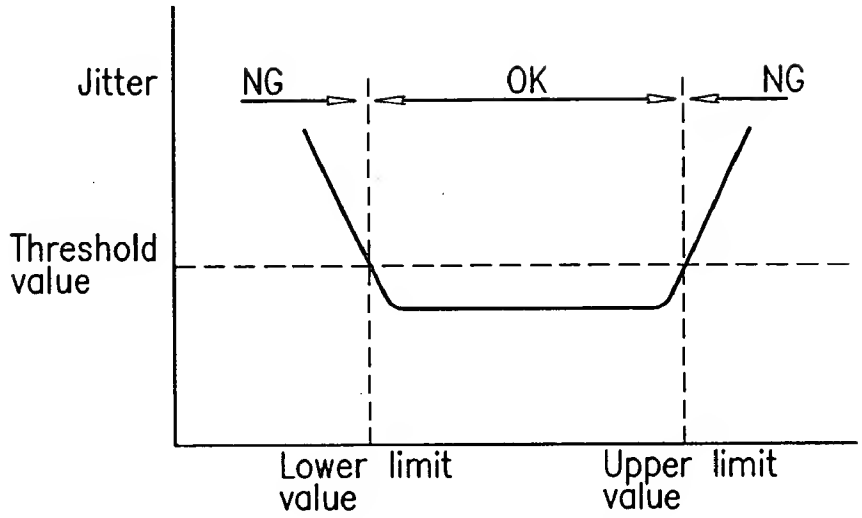


FIG. 55B

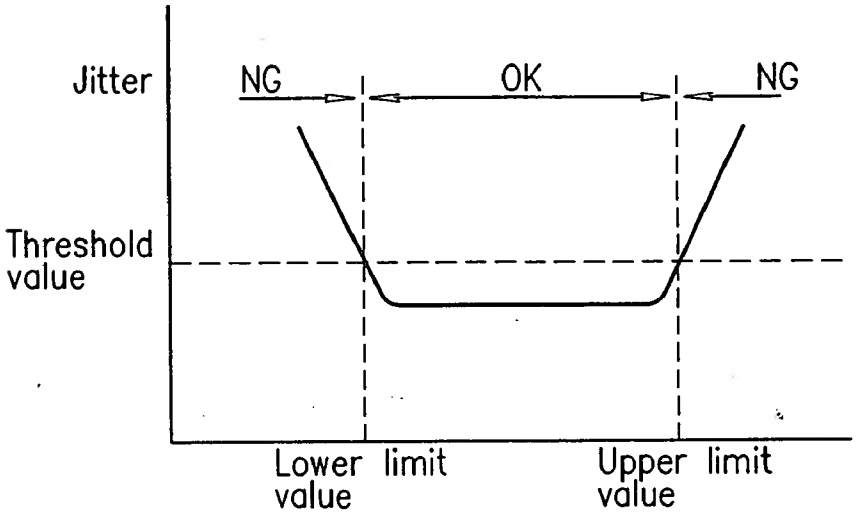


FIG. 56A

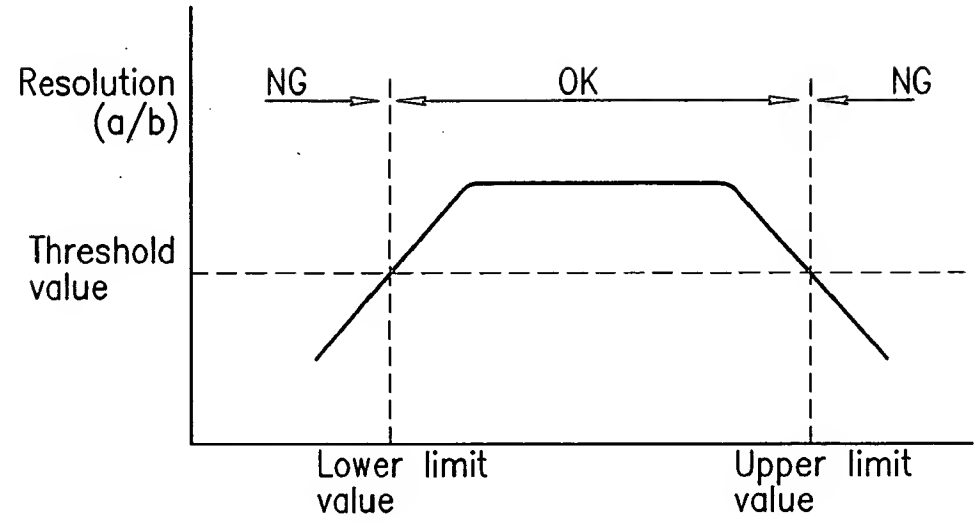


FIG. 56B

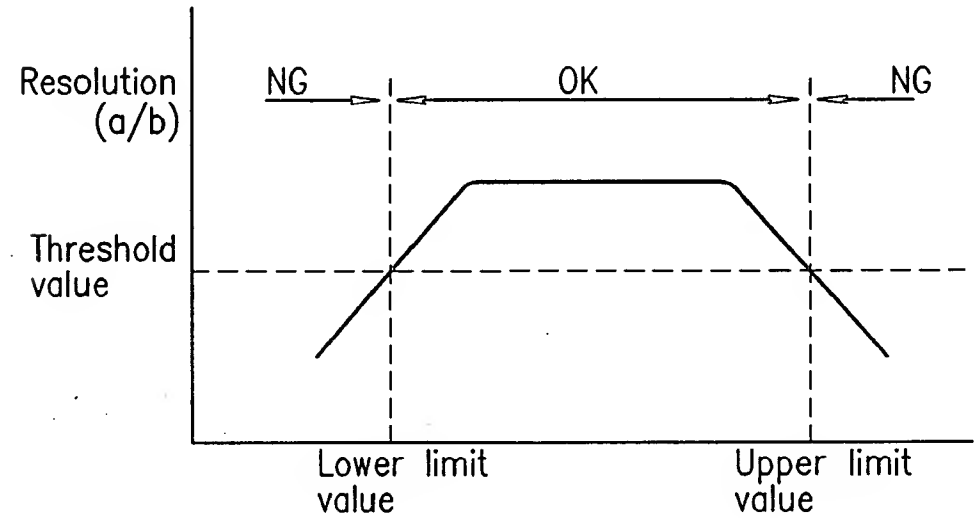


FIG. 57A

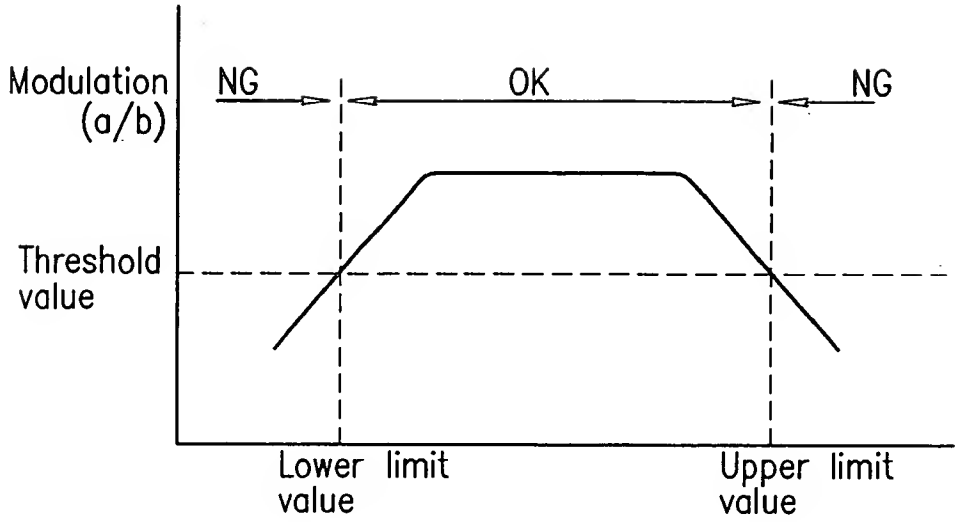


FIG. 57B

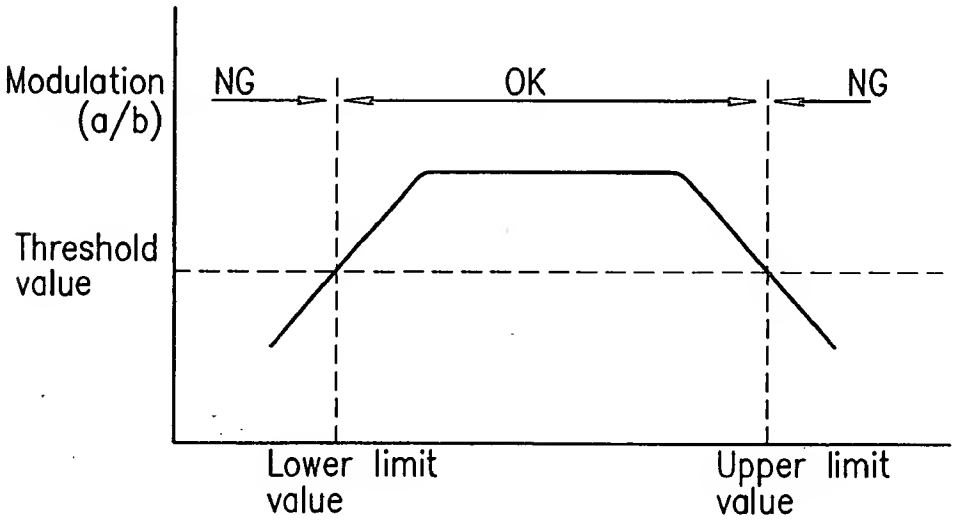


FIG. 58A

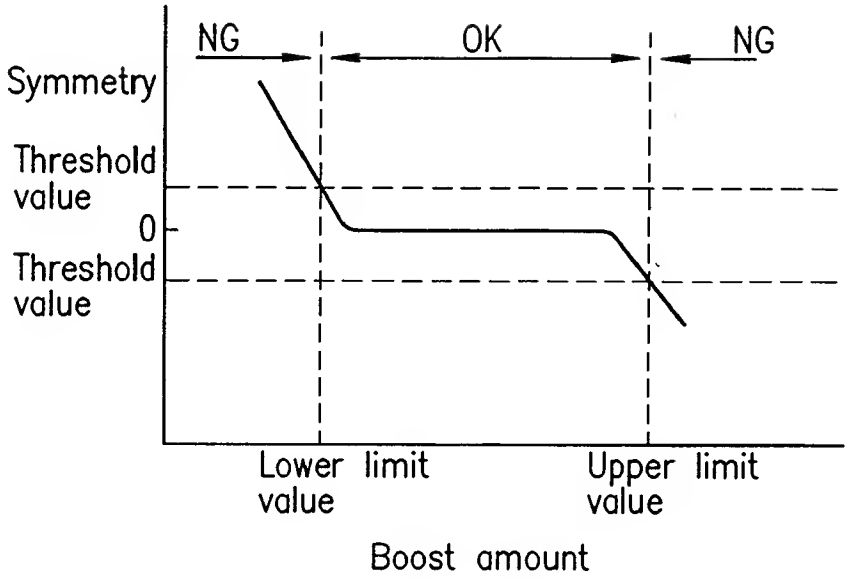


FIG. 58B

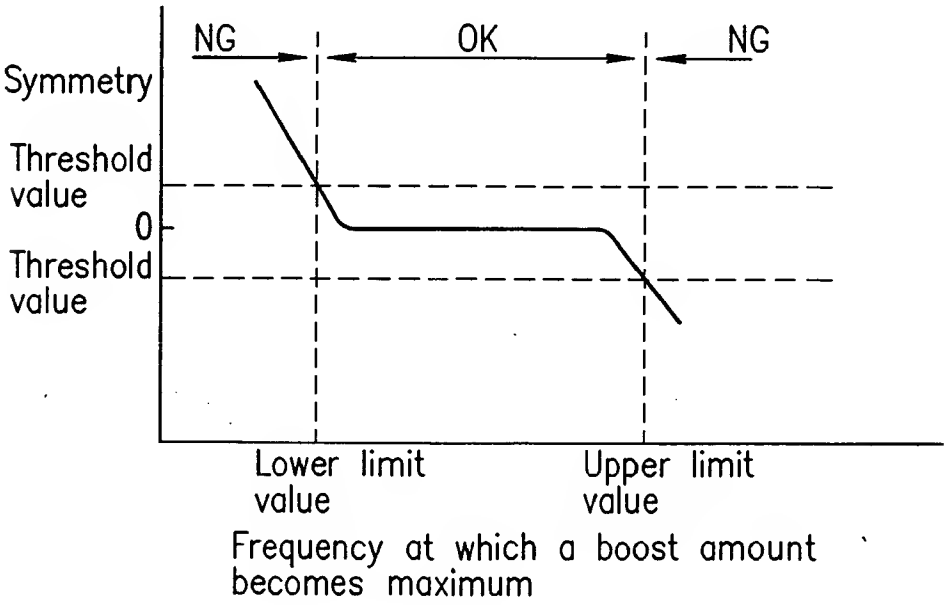


FIG. 59

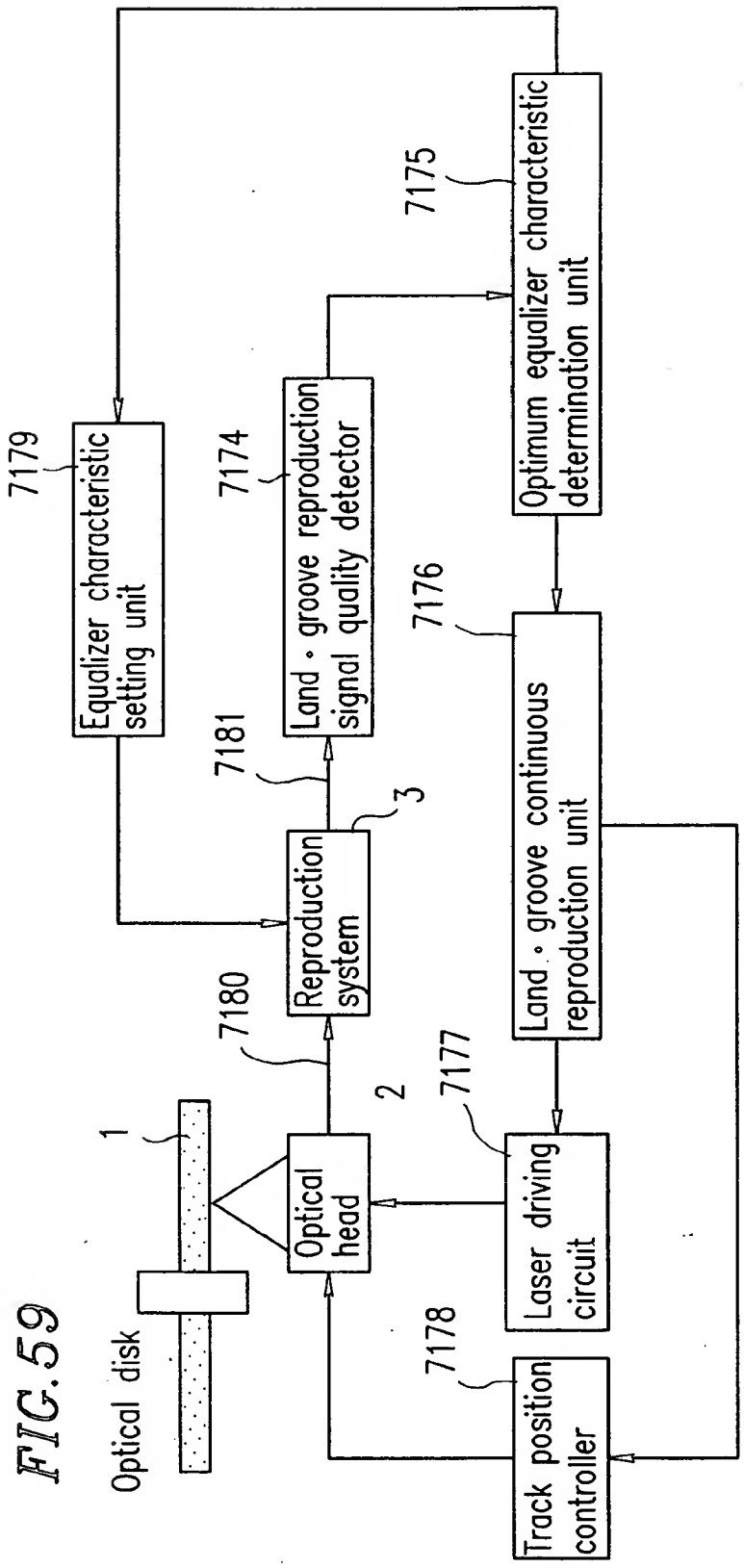
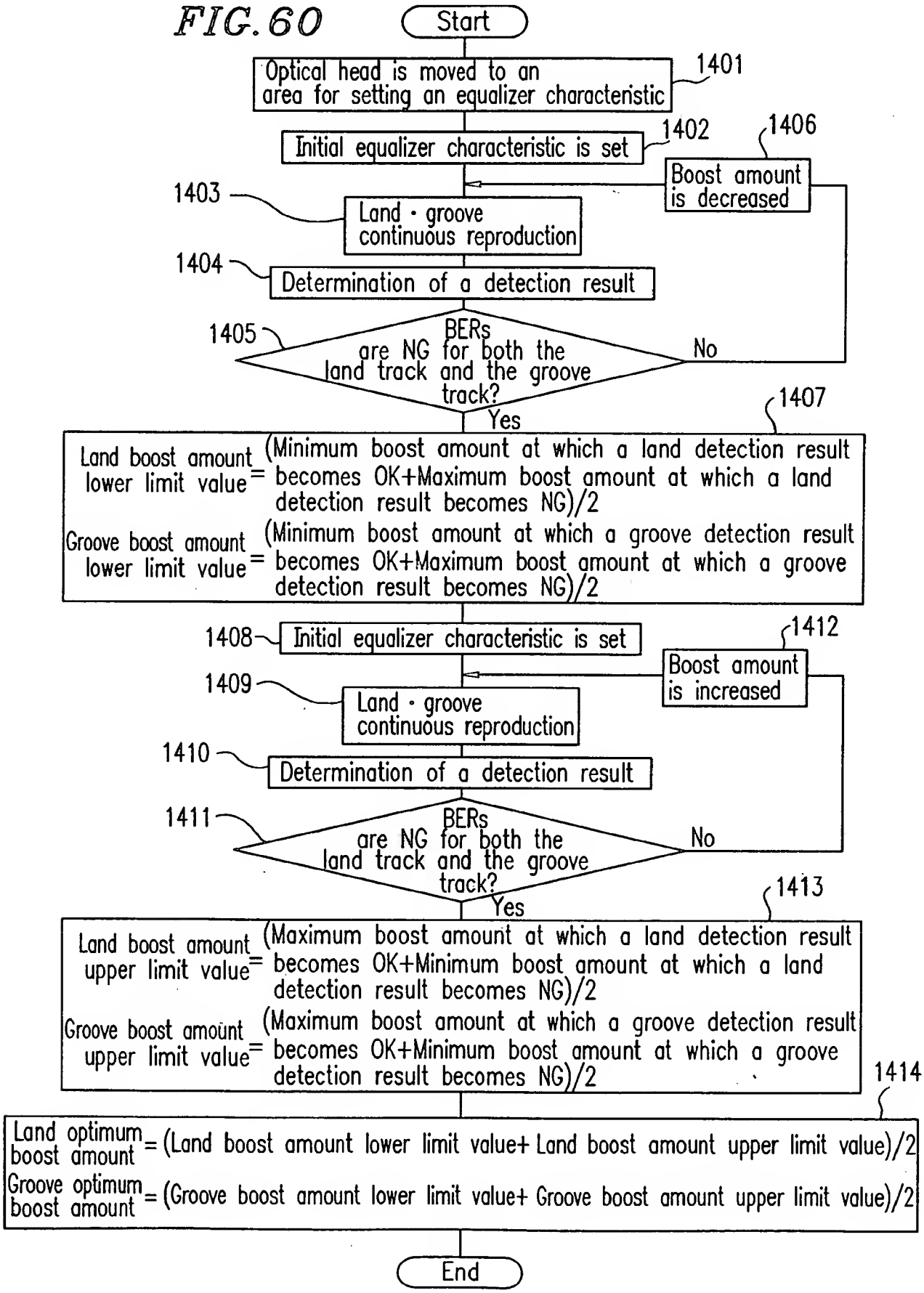

Optical disk
1
Optical head
2
Reproduction system
3
Equalizer characteristic setting unit
Land・groove reproduction signal quality detector
Optimum equalizer characteristic determination unit
Land・groove continuous reproduction unit
Laser driving circuit
Track position controller
7174
7175
7176
7177
7178
7179
7180
7181

FIG. 60


Start
Optical head is moved to an area for setting an equalizer characteristic
1401
Initial equalizer characteristic is set
1402
1406
Boost amount is decreased
1403
Land · groove continuous reproduction
1404
Determination of a detection result
1405
BERs are NG for both the land track and the groove track?
No
Yes
1407
Land boost amount lower limit value = (Minimum boost amount at which a land detection result becomes OK+Maximum boost amount at which a land detection result becomes NG)/2
Groove boost amount lower limit value = (Minimum boost amount at which a groove detection result becomes OK+Maximum boost amount at which a groove detection result becomes NG)/2
1408
Initial equalizer characteristic is set
1412
Boost amount is increased
1409
Land · groove continuous reproduction
1410
Determination of a detection result
1411
BERs are NG for both the land track and the groove track?
No
Yes
1413
Land boost amount upper limit value = (Maximum boost amount at which a land detection result becomes OK+Minimum boost amount at which a land detection result becomes NG)/2
Groove boost amount upper limit value = (Maximum boost amount at which a groove detection result becomes OK+Minimum boost amount at which a groove detection result becomes NG)/2
1414
Land optimum boost amount = (Land boost amount lower limit value+ Land boost amount upper limit value)/2
Groove optimum boost amount = (Groove boost amount lower limit value+ Groove boost amount upper limit value)/2
End

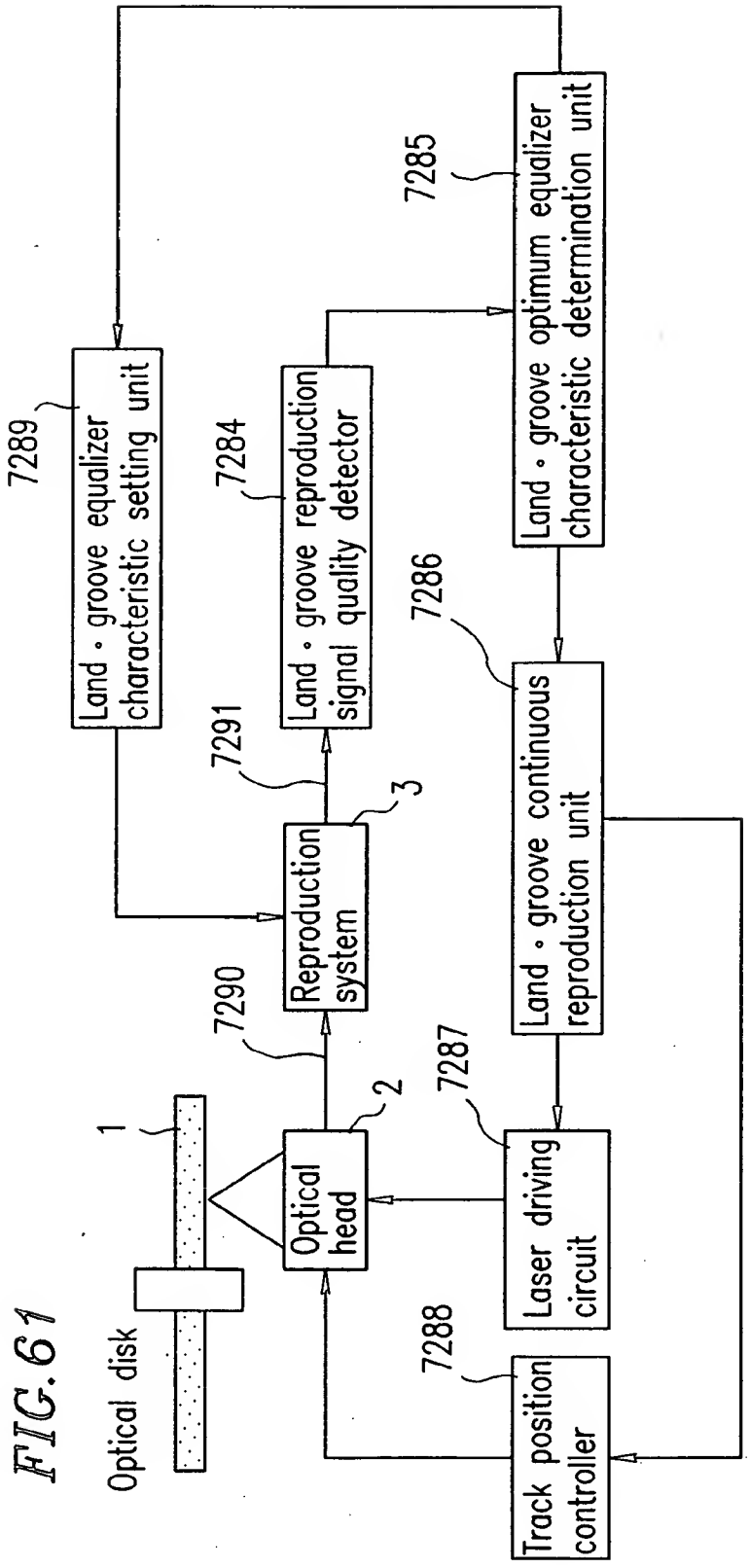

Optical disk
1
Optical head
2
Reproduction system
3
Land • groove equalizer characteristic setting unit
Land • groove reproduction signal quality detector
Land • groove optimum equalizer characteristic determination unit
Land • groove continuous reproduction unit
Laser driving circuit
Track position controller
7284
7285
7286
7287
7288
7289
7290
7291

FIG. 61

FIG. 62

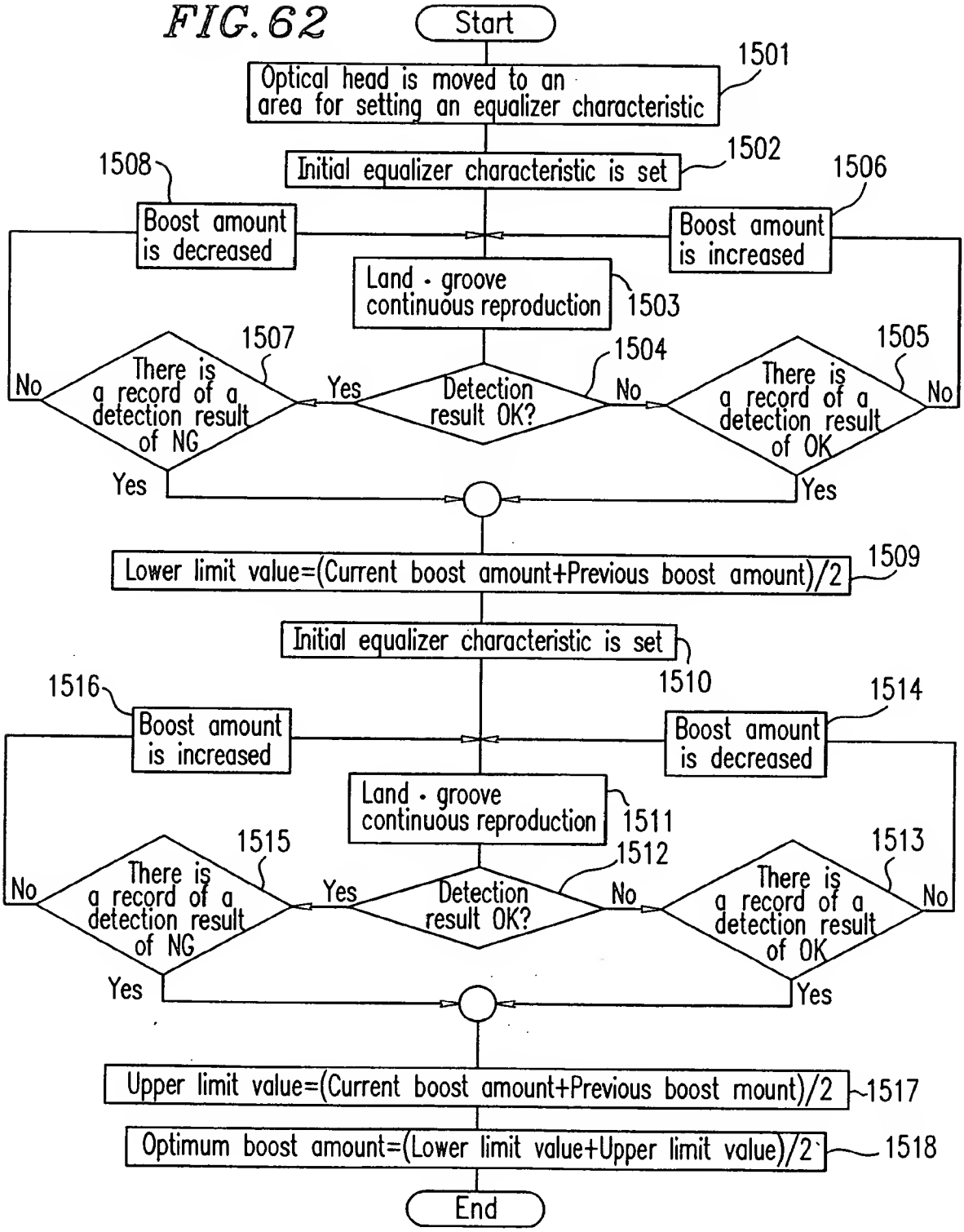
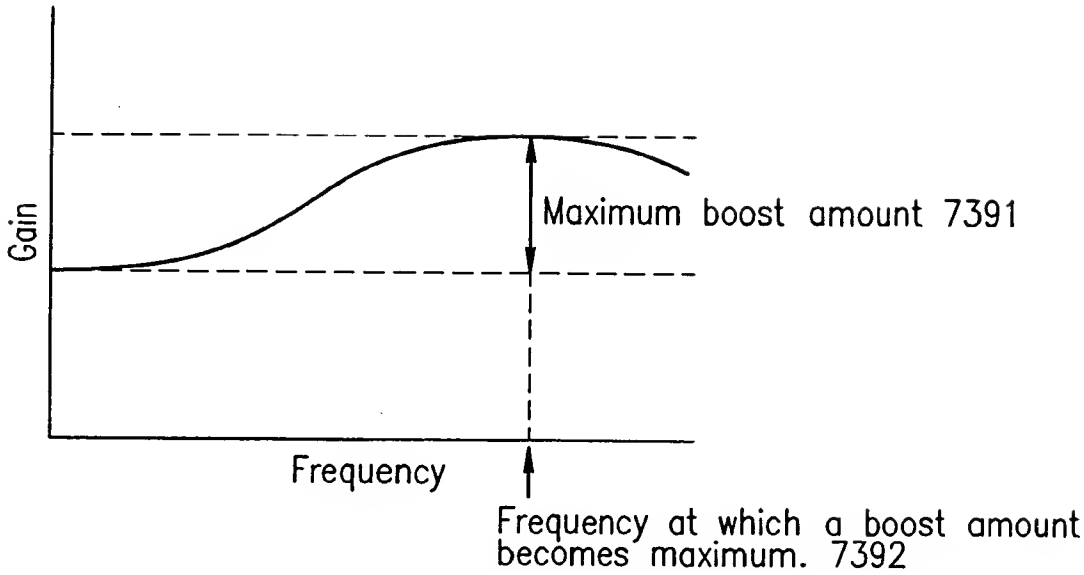

Start
Optical head is moved to an area for setting an equalizer characteristic
1501
Initial equalizer characteristic is set
1502
1508
Boost amount is decreased
1506
Boost amount is increased
Land · groove continuous reproduction
1503
1507
There is a record of a detection result of NG
No
Yes
1504
Detection result OK?
No
Yes
1505
There is a record of a detection result of OK
No
Yes
Lower limit value=(Current boost amount+Previous boost amount)/2
1509
Initial equalizer characteristic is set
1510
1516
Boost amount is increased
1514
Boost amount is decreased
Land · groove continuous reproduction
1511
1515
There is a record of a detection result of NG
No
Yes
1512
Detection result OK?
No
Yes
1513
There is a record of a detection result of OK
No
Yes
Upper limit value=(Current boost amount+Previous boost mount)/2
1517
Optimum boost amount=(Lower limit value+Upper limit value)/2
1518
End

FIG. 63



Equalizer characteristic

FIG. 64

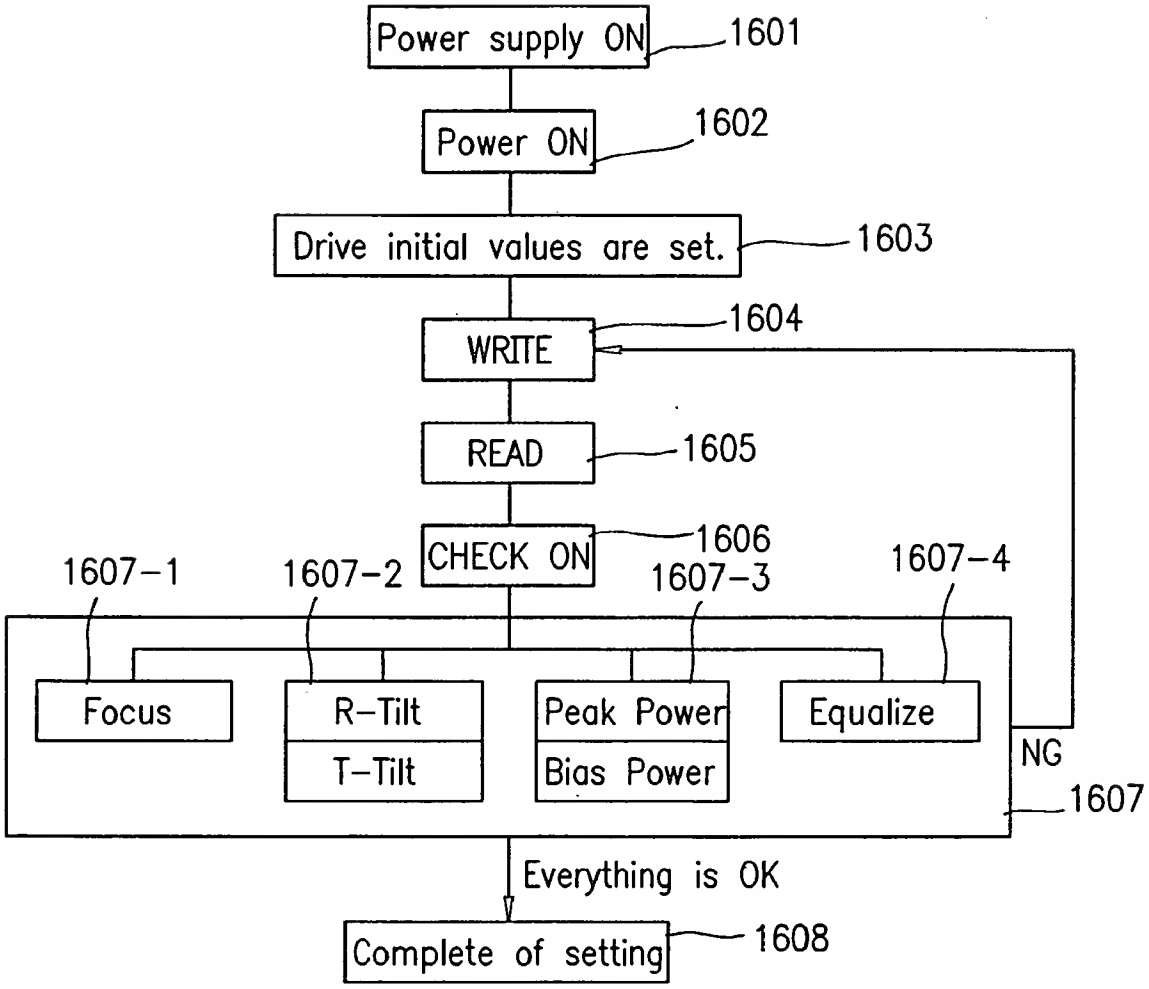
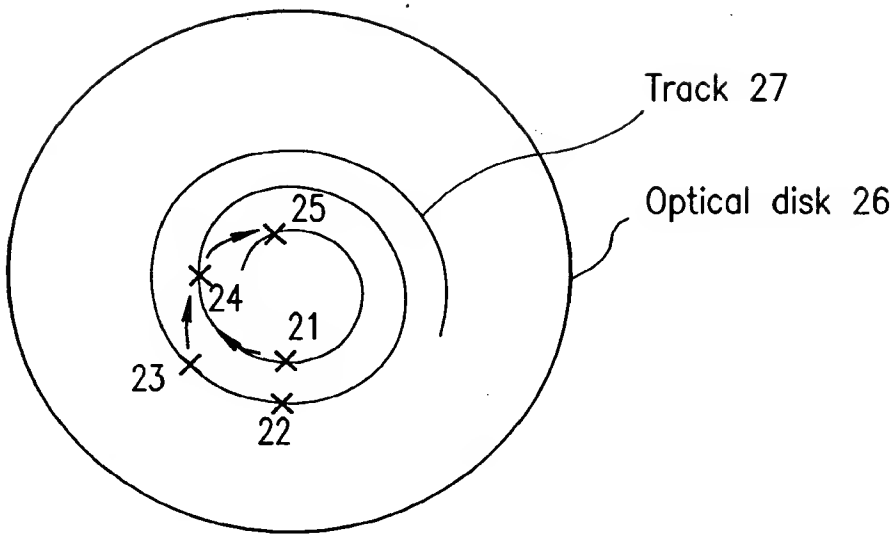

Power supply ON
1601
Power ON
1602
Drive initial values are set.
1603
WRITE
1604
READ
1605
CHECK ON
1606
1607-1
1607-2
1607-3
1607-4
Focus
R-Tilt
T-Tilt
Peak Power
Bias Power
Equalize
NG
1607
Everything is OK
Complete of setting
1608

FIG. 65



PRIOR ART